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FEE TRANSMITTAL
For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 500.00

Complete if Known	
Application Number	10/799056
Filing Date	March 12, 2004
First Named Inventor	Win-Chung Lee, Et Al.
Examiner Name	William K. Cheung
Art Unit	1713
Attorney Docket No.	AD6995USNA

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

☑ Deposit Account Deposit Account Number: 04-1928 Deposit Account Name: E. I. du Pont de Nemours and Company

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	FILING FEES Small Entity Fee ($)	SEARCH FEES Fee ($)	SEARCH FEES Small Entity Fee ($)	EXAMINATION FEES Fee ($)	EXAMINATION FEES Small Entity Fee ($)	Fees Paid ($)
Utility	☐ 300	150	☐ 500	250	☐ 200	100	0.00
Design	☐ 200	100	☐ 100	50	☐ 130	65	0.00
Plant	☐ 200	100	☐ 300	150	☐ 160	80	0.00
Reissue	☐ 300	150	☐ 500	250	☐ 600	300	0.00
Provisional	☐ 200	100	☐ 0	0	☐ 0	0	0.00

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	50	25
Each independent claim over 3 (including Reissues)	200	100
Multiple dependent claims	360	180

Total Claims	Extra Claims	Fee ($)	Fee Paid ($)
_____ - 20 or HP =	_____	x 50.00	= _____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims	Extra Claims	Fee ($)	Fee Paid ($)
_____ - 3 or HP =	_____	x 200.00	= _____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims

Fee ($)	Fee Paid ($)
YES ☐ 360.00	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee ($)	Fee Paid ($)
_____ - 100 =	_____ / 50 =	_____ (round up to a whole number) x	250.00	= _____

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	
Other (e.g., late filing surcharge): Appeal Brief	500.00

SUBMITTED BY

Signature	Mark D. Kuller	Registration No. (Attorney/Agent) 31,925	Telephone (302) 892-1354
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Signature

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Typed or printed name of person signing Certificate

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10/799056

AD6995USNA

Fee Transmittal (1 page)
Appellants' Appeal Brief (12 pages)
Appendix A (2 pages)
Appendix B (2 pages)
Appendix C (1 page)
Enclosed documents
Postcard

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

IN THE APPLICATION OF:

WIN-CHUNG LEE ET. AL. CASE NO.: AD6995 US NA

APPLICATION NO.: 10/799056 GROUP ART UNIT: 1713

FILED: MARCH 12, 2004 EXAMINER: WILLIAM K. CHEUNG

FOR: POLYAMIDE AND POLYVINYLBUTYRAL COMPOSITIONS AND BLENDS COMPRISING MINERAL FILLER AND ARTICLES MADE THEREFROM

APPELLANTS' APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Appellants respectfully submit this Appeal Brief and request that the Board reverse the final rejections of claims 1 to 21 under 35 U.S.C. § 103(a).

Real Party in Interest

E. I. du Pont de Nemours and Company is the real party in interest.

Related Appeals and Interferences

There are no appeals, interferences, or judicial proceedings related to the present application.

Status of Claims

All claims stand finally rejected under 35 U.S.C. § 103(a). The claims on appeal are claims 1 through 21, which are set forth in full in the Claims Appendix, below.

Status of Amendments

Applicants believe that all amendments filed during prosecution have been entered, except that the Revised Amendment filed April 7, 2006, were entered instead of (a) the amendments in the Supplemental Amendment and Second Supplemental Amendment filed in February 2006, and (b) the amendments in the Amendment filed March 21, 2006. Applicants did not file any amendments to the application or claims in the Response after final Action filed August 25, 2006.

Summary of Claimed Subject Matter

Claim 1 is directed to a thermoplastic polyamide composition comprising: (a) from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral; (b) 95 to 25 weight percent polyamide that is melt processible below about 320°C and which has a number average

molecular weight of at least 5,000; (c) a mineral filler in an amount of from about 10 to about 45 weight percent of the total composition; and (d) optionally a coupling agent. Claim 8 is directed to an article prepared from the composition of Claim 1.

The free-flowing toughener is described, *inter alia*, at page 4, lines 4-12, of the patent application. That section describes use of from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral.

As described at page 4, beginning on line 19, the toughener comprises at least one other component. Claims 2-4 and 21 are directed to preferred tougheners.

The polyamides are described at page 5, lines 5-15. Preferably the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid, as claimed in claims 7 and 14.

Mineral fillers are described at page 5, lines 16-23, and preferably are selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc. Dependent claims directed to mineral fillers are claims 5 and 10-13.

The optional coupling agents are described beginning at page 5, line 24. As described therein, the coupling agent can be a silane compound, and is preferably selected from the group consisting of: gamma-aminopropyltrimethoxysilane; gamma-aminopropyltriethoxysilane; N-2- aminopropyltrialkoxysilane; or N-(2-aminoethyl)-3-aminopropylmethyldialkoxysilane. Claim 6 is directed to the composition comprising from about 0.1 to about 1 wt% of the coupling agent and specifies that the coupling agent is an aminosilane compound.

Claims 8-9 and 16-20 are directed articles. The articles are described beginning at page 9, line 8 of the patent application. Articles include laminate articles, shaped articles, etc. Laminates comprising the polyamide compositions of the present invention can be incorporated into various other articles such as, for example, toys, furniture, cars, trains, automobiles, appliances, boats, acoustic tiles, acoustic flooring, walls, ceilings, roofs, roofing materials or other articles where sound damping and/or tough polymers are desirable.

As described at page 9, lines 21 et seq., in a particularly preferred embodiment, the rigid polyamide compositions of the present invention can be laminated to other polymeric materials such as, for example, thermoplastic elastomers (TPEs). TPEs are thermoplastic materials that have rubber-like properties and are soft to the touch. However, TPEs do not generally have good adhesion to conventional rigid polymers. The polyamide compositions of the present invention can eliminate this adhesion problem and provide suitable laminates with TPEs in many cases.

As described at page 10, lines 1 et seq., in another preferred embodiment, the polyamide compositions of the present invention can be laminated with polyvinyl butyral to

yield polyvinyl butyral laminates having substantial sound reduction properties. Such laminates can find usefulness in applications where sound reduction is important such as, for example: automobile engine compartments; appliances such as washing machines; dryers; refrigerators; air conditioners; furnaces; and similar devices that can create loud noise when in use.

In still another embodiment (described at page 10, lines 10-19), laminates having at least two sheets comprising a polyamide composition of the present invention adhered on the opposite surfaces of a polyvinyl butyral interlayer have improved and structural strength relative to one sheet of the polyamide having twice the thickness of the laminate polyamide sheets. Such laminates can find use in: various parts of an automobile such as the door panels, trunk, hood, floorboard; boat hulls; shipping crates; or other similar uses to impart structure and strength.

Grounds of Rejection to be Reviewed upon Appeal

Whether claims 1-21 are obvious under 35 U.S.C. 103(a) over Blatz (U.S. Pat. No. 5,770,654) in view of Hedrick et al. (U.S. Pat. No. 3,419,517).

Argument

Claims 1-21 stand rejected under 35 U.S.C. 103(a) as being obvious over Blatz (U.S. Pat. No. 5,770,654) in view of Hedrick et al. (U.S. Pat. No. 3,419,517).

Claim 1 is directed to a thermoplastic polyamide composition comprising: (a) from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral; (b) 95 to 25 weight percent polyamide that is melt processible below about 320°C and which has a number average molecular weight of at least 5,000; (c) a mineral filler in an amount of from about 10 to about 45 weight percent of the total composition; and (d) optionally a coupling agent. Claim 8 is directed to an article prepared from the composition of Claim 1.

The Patent Office's position seems to be that Blatz discloses all of the claimed features of the present invention except that Blatz does not describe a polyamide composition comprising a mineral filler. The Patent Office points to Hedrick to supply the teaching of mineral fillers for polyamide compositions, stating that one of ordinary skill in the art would be motivated by an expectation of success to combining the two references and thereby obtain the Applicants' claimed invention.

Applicants submit that the rejection for the reasons that (a) the Action improperly combines the two cited patents, improperly reconstructing the invention through hindsight and ignoring the express language of Blatz. In addition, applicants traverse this rejection for the reason that the invention provides unexpected results.

Rather than summarizing the entire prosecution history and applicants' positions, applicants focus this rejection on three critical points that they believe are being improperly considered by the Patent Office. First, applicants submit that the Patent Office is not properly

construing the teachings of Blatz. Second applicants submit that the Patent Office misapplies Hedrick. Third, applicants submit that the Patent Office has not properly considered the evidence submitted to show that unexpected results are obtained with the invention.

(1) First, applicants submit that the Patent Office is not properly construing the teachings of Blatz. This point revolves around the use of the phrase "consisting essentially of" in Blatz. Both applicants and the Patent Office have recognized that the terms appear in the Summary of the Invention, not just in the claims. Applicants submit that this term, construed along with the other teachings of Blatz, shows that Blatz teaches away from the invention. In contrast, the Patent Office is taking the position that the term "consisting essentially of" merely indicates a preference, and then seems to assert since it is only a preference the person of ordinary skill in the art would ignore it, because of the teachings of Hedrick. The Action is clearly misapplying the law. In addition, the Patent Office is misconstruing the facts before it.

The position taken by the Patent Office can be seen from the following statement in the final Action:

> "However, applicants continue to fail to recognize that teachings in the claims or Summary of Blatz only represent the preferable embodiment of the disclosed invention. One of ordinary skill in the art would have studied all of the embodiments taught in Blatz to recognize that the incorporation of mineral filler is a viable way to further modify the disclosed invention (col. 4, line 20-23, 27-31). Therefore, the examiner maintains that Blatz and Hedrick et al. are combinable."

For reference, the two portions at column 4 that the Action points are describing uses of small amount of inorganic or organic powder to prevent agglomeration of recovered polyvinyl butyral flake and to use of 23% plasticizer. The Action ignores the fact that Blatz column 4, lines 23-24, teaches use of "1% powdered high density polyethylene" to reduce the agglomeration, which is about $1/10^{th}$ the amount of filler of the instant claims. In addition, the Action pointing to column 4, lines 27-31 does not support the position the Action is making, since that portion refers to the amount of the plasticizer in the polyvinyl butyral, which is already described in the Summary and the claims. In other words, applicants respectfully submit that the Action doesn't (and can't) point to any teaching in Blatz that supports the point it is trying to make.

Applicants point out that Blatz is specifically directed to an unfilled composition. Blatz's use of "consisting essentially of" to describe the Blatz composition in the Summary of the Invention shows Blatz's intention to describe the specific composition described therein, not merely a preferred embodiment.

Blatz discloses polyamide compositions that consist essentially of plasticized polyvinyl butyral and polyamide. These compositions do not include filler.

Most notably, the Summary of the Invention of Blatz uses the transitional phrase "consisting essentially of" in describing the Blatz composition. The Summary of the Invention of a patent describes the invention in the broadest terms contemplated by the inventors and is not merely focused on a preferred embodiment as asserted in the Action.

Here, it is very important to focus on the fact that the phrase "consisting essentially of" appears in the Summary of the Invention, not just in the claims, and that the phrase is used in the first description of the invention, not in describing a preferred embodiment. This shows the intent of the inventors to limit the scope of the invention to the specified materials and those that do not materially affect the basic and novel characteristic(s) of the claimed invention. See, e.g., MPEP 2111.03.

In this regard, applicants strongly assert that addition of 10% or more of mineral filler materially affect the basic and novel characteristic(s) of the claimed invention, and point to the examples in support of this point.

The fact that the Summary of the Invention describes the invention, not simply a preferred embodiment, can be seen from 37 CFR 1.73 and MPEP 608.01(d). A Summary of the Invention is required in a patent application according to 37 CFR 1.73, which states:

> "A brief summary of the invention indicating its nature and substance, which may include a statement of the object of the invention, should precede the detailed description. Such summary should, when set forth, be commensurate with the invention as claimed and any object recited should be that of the invention as claimed."

MPEP 608.01(d), describes the Summary of the Invention portion of a patent application as follows:

> "Since the purpose of the brief summary of invention is to apprise the public, and more especially those interested in the particular art to which the invention relates, of the nature of the invention, the summary should be directed to the specific invention being claimed, in contradistinction to mere generalities which would be equally applicable to numerous preceding patents. That is, the subject matter of the invention should be described in one or more clear, concise sentences or paragraphs. ..."

> "The brief summary, if properly written to set out the exact nature, operation, and purpose of the invention, will be of material assistance in aiding ready understanding of the patent in future searches. ..."

Given the fact that Blatz uses the transitional phrase "consisting essentially of" in the first description of the invention in Blatz's Summary of the Invention, the invention of Blatz was clearly intended to exclude items such as filler. The Summary

of the Invention is not merely describing a preferred embodiment, it is describing the invention itself. This shows the intent of the Blatz inventors to limit the scope of the invention to the specified materials and those that do not materially affect the basic and novel characteristic(s) of the claimed invention. See, e.g., MPEP 2111.03. In this regard, applicants strongly assert that addition of 10% or more of mineral filler materially affect the basic and novel characteristic(s) of the claimed invention, and point to the examples in support of this point. Therefore, the cited patents cannot be combined as in the rejection, and for this reason alone the rejection is an improper hindsight rejection.

The final Action considered the above arguments and took the position that Blatz's contains teachings that show that fillers are contemplated by Blatz. The Action states that since Blatz column 4, lines 20-23 and 27-31 teaches the "incorporation of inorganic powder or pigments is acceptable", so that "the incorporation of an inorganic material such as filler will not affect the basic properties of the composition of Blatz."

Blatz states:

> "The polyamide was in all cases pelletized commercial nylon 6 available from Allied-Signal Company under the trademark CAPRON®. PVB was recovered, colored trim material, in flake form, having dimensions of about 6.35x6.35x(0.5 to 2.0) mm. Recovered plasticized PVB flake is quite tacky and tends to agglomerate. Because of that, it is practical to dust it with an inorganic or organic powder to prevent agglomeration. In this case, PVB flake was dusted with 1% of powdered high density polyethylene. This PVB was made from polyvinyl alcohol obtained from fully hydrolyzed polyvinyl acetate, leaving about 23% of the initial hydroxyl groups free, i.e., unconverted to ketal groups. The plasticizer was tetraethylene glycol di(n-heptanoate), which was present in an amount of about 23% of recovered PVB. Small amounts of dyes, pigments, and stabilizers were also present in this material."

Applicants submit that the Action misconstrues the teachings of Blatz and the implications thereof. Here, it is necessary to look at the specific teachings of Blatz column 4, lines 20-23 and 27-31, which are cited in the Action. Column 4, lines 21-23, discusses the problems associated with PVB flake agglomerating. Blatz teaches that it is practical to dust PVB used in the composition with an inorganic or organic powder to prevent agglomeration. Then, Blatz goes on to provide an example of dusting PVB flake with 1% of powdered high density polyethylene. Blatz teaches using small amounts of inorganic or organic powder to prevent agglomeration, such as 1% of powdered high density polyethylene. The person of ordinary skill in the art would not be led by that teaching to disregard Blatz express and repeated use of "consisting essentially of" and add mineral filler in an amount of from about

10 to about 45 weight percent of the total composition to a thermoplastic polyamide composition.

Concerning the above, applicants point out that the claims are directed to use of more than ten times the amount of filler than in Blatz and are using the filler in an entirely different way and for entirely different purposes. Therefore, the person of ordinary skill in the art would not combine the documents as asserted.

Blatz also teaches that "Small amounts of dyes, pigments, and stabilizers were also present in this material." While there is no teaching of the specific amounts of these additives, again applicants point to the fact that Blatz is teaching use of "small" amounts of these additives and does not disclose which ones or suitable amounts. Certainly there is no basis for concluding that this teaching would lead the person of ordinary skill in the art to read into the claims that use of mineral filler in an amount of from about 10 to about 45 weight percent of the total composition to a thermoplastic polyamide composition. Moreover, the person of ordinary skill in the art would not consider those amounts of additives to have the significant impact on the composition that the larger amounts used in this invention provide.

Applicants also point out that the Action pointing to column 4, lines 27-31 in support of the rejection does not make sense. That portion refers to the amount of the plasticizer in the polyvinyl butyral. The specification and claims of Blatz describe a plasticized polyvinyl butyral, containing 15-35 weight % plasticizer. Thus, this portion of the specification is referring to the composition of the plasticized polyvinyl butyral, not to addition of an additive.

In fact, considering the above teachings, applicants submit that addition of 10% or more of mineral filler materially affects the basic and novel characteristic(s) of the claimed invention, and point to the examples of the invention in support of this point. The person of ordinary skill in the art is led away from using such a large amount of filler by Blatz given the use of the phrase "consisting essentially of" in conjunction with teachings of using very small amounts of items other than the specific items mentioned in Blatz.

Applicants also point out that Blatz was filed after Hedrick, so clearly Blatz would have had the knowledge of Hedrick available. Therefore, Blatz's choosing to exclude the use of fillers as claimed must be construed in view of the fact that Blatz made that choice despite the earlier teachings of Hedrick, thus supporting the assertion that Blatz not only chose to exclude things other than those described in its specification, but did so despite the earlier teachings of Hedrick.

For the above reasons alone, the rejection under 103 should be withdrawn.

(2) Second, applicants point out that Hedrick is describing a composition comprising nylon and mineral filler, but does not teach use of from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral. There is nothing in either Blatz or Hendrick that would indicate the compatibility of the toughener in filled systems, and thus there is nothing that would motivate

the person of ordinary skill in the art to combine the cited patents as in the rejection. It is noted that the final Action concludes that since Hedrick teaches uses of silane coupling agent along with use of the fillers there is no issue, but fails to point to anything in Hedrick or Blatz that establishes that the mention of use of a silane coupling agent would be considered by the person of ordinary skill in the art to combine the documents as in the rejection. In particular, the Action fails to establish why this disclosure of Hedrick would motivate the person of ordinary skill in the art to the claimed invention, particularly given the lack of teachings concerning compatibility and the fact that the person of ordinary skill in the art would be disregarding the express teachings of Blatz. Applicants submit that the Action completely fails to point to any teachings in either reference concerning compatibility or to explain the basis for its conclusions. Thus, applicants submit that the rejection is improper.

(3) Third, Applicants also submit that the claimed invention provides an unexpected balance of both strength, as demonstrated by flexural modulus (stiffness), and impact, as demonstrated by notched izod. This can be seen by comparing the invention with nylon 6 and nylon 6,6 data. Applicants submitted a detailed argument concerning this point in their prior response, and applicants' position was dismissed in the Action. The Action states that "Applicants must recognize that it is well known in the art of polymer composite materials that when a toughener is added to plastic materials, the plastic materials are expected to be improved in mechanical properties such as Notched Izod Impact properties." Based upon this, the Action states that applicants' arguments are not persuasive.

The Action totally ignores the fact that the data presented shows a general trend in the literature for nylon 6 and nylon 66, including impact grades, is for addition of mineral to provide an increase in strength (stiffness) and a significant decrease in impact. The data presented shows that this trend can be unexpectedly reduced by adding the tougheners of this invention. In fact, Example 4 actually obtained better impact than would be expected based upon the literature data.

Concerning this point, please note that the Action discusses the data as if it merely compares data obtained with the system of the invention and nylon 66. Applicants' present data showing nylon, mineral filled nylon, impact grade nylon and mineral filled impact grade nylon that shows that addition of mineral to provide an increase in strength (stiffness) and a significant decrease in impact, whereas the data presented shows that this trend can be unexpectedly reduced by adding the tougheners of this invention.

In order to provide a comparison, applicants have compared data in the patent application with data available in the public domain. Much of the data concerning nylon 6 and nylon 6,6 was obtained from MatWeb ***http://www.matweb.com/***. Data is also presented from the DuPont Zytel® Nylon Resin Product and Properties Guide, available at ***http://www.plastics.dupont.com/plastics/pdflit/americas/zytel/231094d.pdf?GXHC_locale=en_US***.

In order to view the comparison, applicants have provided the following table summarizing the data in the patent application and public domain information. Please note that in some cases the Notched Izod data was multiplied by 100 in order to present all of the data in J/m units (instead of presenting some in J/cm). Please also note that the data is not intended to show comparison measured using the same techniques and equipment, and instead is intended to show trends.

Sample	Strength Flexural Modulus (Gpa)	Impact Notched Izod (J/m)
Nylon 6	2*	250*
Nylon 6, 30% Mineral Filled	3.9*	81*
Nylon 6, 40% Mineral Filled	4.8*	65*
Nylon 6, Impact Grade	1.6*	680*
Nylon 6, Mineral Reinforced, Impact Grade	3.2*	160*
Nylon 66	2.4*	150*
Nylon 66, 10% Mineral Filled	4.2*	89*
Nylon 66, 20% Mineral Filled	6.1*	46*
Nylon 66, 30% Mineral Filled	7.1*	100*
Nylon 66, 40% Mineral Filled	6.7*	60*
Nylon 66, Impact Grade	2.1*	550*
Nylon 66, Mineral Filled, Impact Grade	4.6*	76*
Nylon 6,6 – Zytel® 101 (from MatWeb)	2.83	-
Nylon 6,6 – Zytel® 101, 30% Mineral Filled (from MatWeb)	6.55	-
Zytel® 101 (from DuPont literature)	2.83	53
60% Zytel® 101 Nylon, 40% Mineral - Comparative Example 2	4.95	44.5
51% Zytel® 101 Nylon, 40% Mineral, 9% Free-Flowing Toughener – Ex. 1	4.43	45.8
48% Zytel® 101 Nylon, 40% Mineral, 12% Free-Flowing Toughener – Ex. 2	3.93	48.7
42% Zytel® 101 Nylon, 40% Mineral, 18% Free-Flowing Toughener – Ex. 3	2.71	45.7
42% Zytel® 101 Nylon, 40% Mineral, 18% Free-Flowing Toughener (9% polyolefin having anhydride functionality) – Ex. 4	3.02	57

*Average

From the above, it can be seen that the general trend shown in the literature for nylon 6 and nylon 66, including impact grades, is for addition of mineral to provide an increase in strength (stiffness) and a significant decrease in impact. Unexpectedly this trend can be reduced by adding the tougheners of this invention. In fact, Example 4 actually obtained better impact than would be expected based upon the literature data.

To better understand the data, consider this excerpt from the above table:

Sample	Strength Flexural Modulus (Gpa)	Impact Notched Izod (J/m)
Nylon 66	2.4*	150*
Nylon 66, 10% Mineral Filled	4.2*	89*
Nylon 66, 20% Mineral Filled	6.1*	46*
Nylon 66, 30% Mineral Filled	7.1*	100*
Nylon 66, 40% Mineral Filled	6.7*	60*
Nylon 66, Impact Grade	2.1*	550*
Nylon 66, Mineral Filled, Impact Grade	4.6*	76*

From this table, it can be seen that addition of impact modifier increases the average Notched Izod value for Nylon 66 polymers. That is, the average Notched Izod rises from 150 J/m to 550 J/m. However, when mineral filler is added the Notched Izod values are substantially lower than the values obtained with Nylon 66 by itself. From the data, it appears that the mineral filler seems to destroy the benefit obtained with the impact modifier.

Comparing the literature value for Zytel® 101 nylon resin to the value of Comparative Example 2, it can be seen that the mineral filler also reduces the impact values obtained with Zytel® 101 nylon resin. However, when the toughener of the invention is used in mineral filled systems, the impact values are comparable or better than those obtained with Zytel® 101 nylon resin by itself. This result is unexpected.

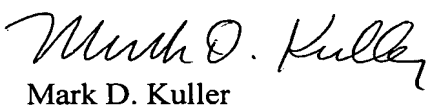
For all of the above reasons, applicants respectfully request withdrawal of the rejection of the claims as obvious over Blatz in view of Hedrick.

Conclusions

For the above reasons, Appellants respectfully submit that claims 1 through 21 are in condition for allowance. Accordingly, Appellants respectfully request that the Board reverse the final rejections of claims 1 through 21 under 35 U.S.C. § 103(a), and remand the application to the Examiner for passage to issue.

Please charge Appellants' Appeal Brief fee ($500.00) and any additional fees that may be due in connection with this Appeal Brief, or render any credits, to Deposit Account 04-1928 (E. I. du Pont de Nemours and Company). A fee sheet is submitted herewith.

Respectfully submitted,



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Dated: January 12, 2007

Appendix A - Claims Appendix

1. A thermoplastic polyamide composition comprising: (a) from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral; (b) 95 to 25 weight percent polyamide that is melt processible below about 320°C and which has a number average molecular weight of at least 5,000; (c) a mineral filler in an amount of from about 10 to about 45 weight percent of the total composition; and (d) optionally a coupling agent.

2. The composition of Claim 1 wherein the toughener comprises one or more polymers having anhydride functionality or one or more polymers having carboxylic acid functionality.

3. The composition of Claim 1 wherein the toughener additionally comprises a non-reactive polymer.

4. The composition of Claim 3 wherein the non-reactive polymer is selected from the group consisting of polyethylene, polypropylene, polyvinylchloride, nylon, olefinic copolymers, and mixtures thereof.

5. The composition of Claim 1 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

6. The composition of Claim 1 comprising the coupling agent wherein the coupling agent is an aminosilane compound and is included in an amount of from about 0.1 to about 1 wt%.

7. The composition of Claim 1 wherein the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid.

8. An article prepared from the composition of Claim 1.

9. The article of Claim 8 wherein the article is selected from articles in the group consisting of: toys; furniture; cars; trains; automobiles; appliances; boats; acoustic tiles; acoustic flooring; walls; ceilings; roofs; and, roofing materials.

10. The composition of Claim 2 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

11. The composition of Claim 4 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

12. The composition of Claim 6 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

13. The composition of Claim 7 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

14. The composition of Claim 11 wherein the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid.

15. The composition of Claim 12 wherein the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid.

16. An article prepared from the composition of Claim 2.

17. An article prepared from the composition of Claim 5.

18. An article prepared from the composition of Claim 14.

19. An article prepared from the composition of Claim 15.

20. The article of Claim 8 wherein the article is selected from articles in the group consisting of: toys; furniture; cars; trains; automobiles; appliances; boats; acoustic tiles; acoustic flooring; walls; ceilings; roofs; and, roofing materials.

21. The composition of Claim 1 wherein the toughener comprises one or more polymers having anhydride functionality.

Appendix B - Evidence Appendix

Applicants presented evidence in the patent application and submitted evidence available in the public domain during patent prosecution. (Applicants did not submit any evidence pursuant to 37 CFR 1.130, 1.131, or 1.132.) The evidence in the specification is presented at pages 10-14 of the application. Please note that the tables were amended to correct errors during prosecution. Copies of the revised tables are included herein. The evidence from the examples and the public domain were discussed in the Amendment dated July 21, 2006.

The tables in this Appeal Brief were previously presented in responses to Office Actions and are included above.

In the Revised Amendment dated April 7, 2006, applicants presented the following replacement Table 2:

Table 2
Effect of Saline on ECOCITE™ Blends with Mineral Filled Polyamide

	Ex 5	Ex 6	Ex 7	Ex 8
Zytel® 101	51	48	42	42
Silane Silquest® A1100	0.2	0.2	0.2	0.2
ECOCITE™ H (Wt%)	9	12	18	9
Fusabond® A MG423D	-	-	-	9
Translink® HF900	40	40	40	40
Melt Viscosity @ 280°C/2487 s^{-1} (Pa-s)	2337	2124	1860	2125
NI @ 23°C (kJ/m^2)	3.86	4.66	3.76	4.26
NI @ 23°C (J/m)	30.71	37.1	30.03	34.2
UNI @ 23°C (kJ/m2)	60	59.23	48.39	47.98
UNI @ 23°C (J/m)	601.22	592.93	484.39	480.73
TS EL-B (%)	5.6	4.455	6.204	8.33
TS-B (Mpa)	77.868	70.48	66.237	39.539
TS-B (psi)	11301.635	10229.343	9613.563	5738.618
TS-Y (Mpa)	77.947	70.56	66.298	39.6
TS-Y (psi)	11313.104	10240.886	9622.41	5747.502
Flex Mod (Gpa)	6.228	5.664	5.778	3.354
Flex Mod (psi)	903983	822127	838608	486765
Torque (%)	54	57	58	61

In order to provide a comparison, applicants have compared data in the patent application with data available in the public domain. Much of the data concerning nylon 6 and nylon 6,6 was obtained from MatWeb **http://www.matweb.com/**. Data is also presented from the DuPont Zytel® Nylon Resin Product and Properties Guide, available at

http://www.plastics.dupont.com/plastics/pdflit/americas/zytel/231094d.pdf?GXHC_locale=en_US. Copies of printouts of these web pages were previously submitted and additional copies are enclosed herewith.

Copies of Blatz (U.S. Pat. No. 5,770,654) and Hedrick et al. (U.S. Pat. No. 3,419,517) are enclosed herewith.

Documents Enclosed Herewith
Blatz (U.S. Pat. No. 5,770,654)
Hedrick et al. (U.S. Pat. No. 3,419,517)
DuPont Zytel® Nylon Resin Product and Properties Guide, **http://www.plastics.dupont.com/plastics/pdflit/americas/zytel/231094d.pdf?GXHC_locale=en_US**
Overview – Nylon 6, Unreinforced, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 6, 30% Mineral Filled, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 6, 40% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 6, Impact Grade, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 6, Mineral Reinforced, Impact Grade, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, Unreinforced, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, 10% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, 20% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, 30% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, 40% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, Impact Grade, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – Nylon 66, Mineral Reinforced, Impact Grade, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – DuPont Zytel® 101 NC010 Nylon 66, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – DuPont Zytel® FR70M30V0 NC010 Nylon 66, 30% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Overview – DuPont Zytel® FR70M30V0 BK010 Nylon 66, 30% Mineral Filled, MatWeb, The Online Materials Database, **http://www.matweb.com/**
Revised Amendment dated April 7, 2006
US 2004-0266931 A1 (published version of U.S. Application No. 10/799,056)

Product and Properties Guide

DUPONT

Zytel®

nylon resin

Start with DuPont

Zytel® is the DuPont trademark for the many different nylon resins that the company makes. Zytel® nylon resins are thermoplastic polyamides. Since their invention by DuPont over 50 years ago, they have been the most widely used of all engineering plastics. They are tough, withstand repeated impact, and are highly resistant to abrasion and most chemicals. Molded articles retain their shape at elevated temperatures, are strong in thin sections, and have low coefficients of friction. Many compositions are rated V-2 by Underwriters Laboratories Subject 94. Some also qualify for the V-0 rating.

The principal Zytel® nylon resins may be divided by chemical composition into three basic groups—nylon 66, nylon 612, and copolymers, all of which may be modified to give special properties. Compositions in any of these groups may also be made with different molecular weights.

Properties such as melting point, water absorption, and modulus of elasticity are determined primarily by the type of nylon. Impact resistance is affected by the type of modifier used (if any) and molecular weight of the nylon. Melt viscosity is determined mainly by molecular weight. Various additives are used to enhance specific properties (e.g., heat resistance, weather resistance, color stability) and to improve processing (e.g., mold release, screw retraction).

Zytel® nylon resins may be reinforced with glass fibers to increase their tensile strength, stiffness, and dimensional stability.

In addition to the commercially coded compositions, there are many "FE" coded resins designed to have specific attributes. Information concerning such compositions, as well as any other needs, can be obtained from your DuPont representative.

Most of the solid granular material products are supplied in cylinder cut of 2.29×2.54 mm (0.090×0.100 in) nominal dimensions. Other Zytel® nylon resins are supplied in a nominally rectangular cut approximately $3.18 \times 3.18 \times 1.58$ mm ($\frac{1}{8} \times \frac{1}{8} \times \frac{1}{16}$ in). Some compositions are available in colors.

Table 1
Compositions

Designation	Description	Characteristics and Major Uses
Nylon 66—Melt at 262°C (504°F)—Stiff and strong over a wide range of temperatures. Excellent toughness and chemical resistance.		
Zytel® 101	General Purpose—Unlubricated	Basic nylon 66. Unmodified nylon 66 of molding viscosity. The industry standard.
Zytel® 101L	General Purpose—Lubricated	A nylon 66 lubricated for improved machine feed and mold release characteristics. Widely used in injection molding for mechanical parts, consumer products, etc.
Zytel® 101F	General Purpose—Fast Cycle	A non-nucleated nylon 66 for optimum molding performance.
Zytel® 103HSL	Heat Stabilized—Lubricated	New, improved heat stabilized nylon 66 designed to retard embrittlement at high service temperatures. Has a 140°C (284°F) UL rating for electrical use. Optimum stabilization for heat life and good electrical properties. Lubricated for improved machine feed and mold release.
Zytel® 105 BK010A	Weather Resistant	Contains well-dispersed carbon black for maximum resistance to weathering.
Zytel® 122L	Hydrolysis Resistant	Stabilized against hydrolysis and oxidation. For long-term exposure to hot water. Lubricated.
Zytel® 132F	Lubricated, Nucleated Fast Cycle	Internally lubricated and lightly nucleated for high productivity.
Zytel® 42A	High Viscosity for Extrusion	For extrusion into rod, tubing, and complex shapes. Can be molded into parts requiring high impact resistance.
Modified Nylon 66—Melt at 262°C (504°F)—Like nylon 66 with added impact resistance and flexibility.		
Zytel® 408L	General Purpose—Lubricated	A lubricated modified nylon 66 with superior toughness and improved mold release.
Zytel® 408HS	Heat Stabilized	A new, improved heat stabilized modified nylon 66.
Zytel® 3189	General Purpose	Impact strength between Zytel® 408 and Zytel® ST801.
Super Tough Nylons—Melt at 262°C (504°F)—Highest impact resistance of any engineering thermoplastic.		
Zytel® ST801	General Purpose	Outstanding impact resistance. Good moldability.
Zytel® ST801 BK010	Weather Resistant	Contains well dispersed carbon black for maximum resistance to weathering; outstanding impact resistance.
Zytel® ST801HS	Heat Stabilized	Heat stabilized version of Zytel® ST801.
Nylon 612—Melt at 217°C (423°F)—Low moisture absorption and excellent dimensional stability.		
Zytel® 151L	General Purpose—Lubricated	A nylon 612 lubricated for improved machine feed and mold release.
Zytel® 153HSL	Heat Stabilized—Lubricated	Heat stabilized Zytel® 158L to retard embrittlement at high service temperatures. Primarily for wire jacketing.
Zytel® 157HSL BK010	Weather and Heat Resistant—Lubricated	Contains well-dispersed carbon black for maximum resistance to weathering. Heat stabilized. Lubricated for improved machine feed and mold release.
Zytel® 158L	General Purpose—Lubricated	Higher melt viscosity and greater toughness than Zytel® 151L. Lubricated for improved machine feed and mold release.

(continued)

Table 1
Compositions *(continued)*

Designation	Description	Characteristics and Major Uses
Glass-reinforced Nylons—Very high strength, stiffness, and toughness. Excellent creep resistance and dimensional stability.		
Zytel® 70G13L 70G33L 70G43L	General Purpose Nylon 66	Nylon 66 reinforced with 13, 33 and 43% short glass fibers. Lubricated for improved machine feed and mold release.
Zytel® 70G13HS1L 70G33HS1L	Heat Stabilized	Heat stabilized nylon 66 reinforced with 13 and 33% short glass fibers. Lubricated.
Zytel® 70G33HRL	Hydrolysis Resistant	Hydrolysis and oxidation resistance nylon 66 with 33% short glass fibers. Lubricated.
Zytel® 71G13L 71G33L	Impact Modified	Impact modified nylon 66 with 13 and 33% short glass fibers. Greater dimensional stability. Lubricated.
Zytel® 71G13HS1L	Impact Modified, Heat Stabilized	Heat stabilized and impact modified nylon 66 with 13% short glass fibers. Excellent toughness and outstanding dimensional stability.
Zytel® 72G13L 72G33L 72G43L	Nylon Copolymer, Heat Stabilized	Nylon 66/6 copolymer reinforced with 13, 33 and 43% glass fibers. Improved surface appearance.
Zytel® 72G13HS1L	Nylon Copolymer, Heat Stabilized	Heat stabilized nylon 66/6 copolymer reinforced with 13% glass fibers.
Zytel® 74G13L 74G33L 74G43L	Improved Surface	Nylon 66 and nylon 6 co-melt reinforced with 13, 33 and 43% glass fibers. Improved surface appearance and excellent mechanical properties.
Zytel® 77G33L 77G43L	General Purpose Nylon 612	Nylon 612 reinforced with 33 and 43% short glass fibers. Excellent toughness and outstanding dimensional stability.
Zytel® 8018 80G33L	Toughened, General Purpose	Nylon 66 with outstanding impact resistance based on DuPont supertough technology. Reinforced with 14 and 33% short glass fibers.
Zytel® 8018HS 80G33HS1L	Toughened, Heat Stabilized	Heat stabilized, toughened nylon 66 reinforced with 14 and 33% short glass fibers.
Zytel® 82G33L	Nylon Copolymer, Toughened	Nylon 66/6 copolymer available in 33% glass content by weight. Superior impact resistance, excellent surface appearance.
Flame-retarded Nylons		
Zytel® FR	Flame Retarded*	Several compositions are available that have been modified to improve flame and/or ignition resistance (as measured by UL rating, glow wire or LOI) relative to unmodified counterparts.

*Note: Does not indicate combustion characteristics under actual fire conditions.

Table 2
Properties of Zytel® Nylon Resins

	Property[a]	ASTM Method	Unit	Nylon 66[a]						
				General Purpose		Fast Cycling	High Molecular Wt.		Weather Resistant	
				Zytel® 101 Zytel® 101L		Zytel® 101F	Zytel® 42A		Zytel® 105 BK010A	
				DAM	50% RH	DAM	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength									
	–40°C	D 638	MPa	113.8	110.3	—	117.2	111.0	128.9	117.2
	–40°F		psi	16,500	16,000	—	17,000	16,100	18,700	17,000
	23°C		MPa	82.7	77.2	82.8	85.5	77.2	90.3	62.1
	73°F		psi	12,000	11,200	12,000	12,400	11,200	13,100	9,000
	77°C		MPa	62.1	40.7	—	58.6	40.7	62.1	50.3
	170°F		psi	9,000	5,900	—	8,500	5,900	9,000	7,300
	121°C		MPa	42.7	37.9	—	43.4	32.4	47.6	42.1
	250°F		psi	6,200	5,500	—	6,300	4,700	6,900	6,100
	Yield Strength									
	–40°C	D 638	MPa	113.8	110.3	—	117.2	111.0	128.9	117.2
	–40°F		psi	16,500	16,000	—	17,000	16,100	18,700	17,000
	23°C		MPa	82.7	58.6	—	85.5	59.3	90.3	62.1
	73°F		psi	12,000	8,500	—	12,400	8,600	13,100	9,000
	77°C		MPa	44.8	40.7	—	58.6	40.7	47.6	39.3
	170°F		psi	6,500	5,900	—	8,500	5,900	6,900	5,700
	121°C		MPa	33.1	27.6	—	35.2	32.4	34.5	30.3
	250°F		psi	4,800	4,000	—	5,100	4,700	5,000	4,400
	Elongation at Break									
	–40°C (–40°F)	D 638	%	15	20	—	15	35	10	15
	23°C (73°F)		%	60	≥300	52	90	≥300	30	200
	77°C (170°F)		%	≥300	≥300	—	155	≥300	145	250
	121°C (250°F)		%	≥300	≥300	—	200	≥300	≥300	≥300
	Elongation at Yield									
	–40°C (–40°F)	D 638	%	4	—	—	—	5	5	5
	23°C (73°F)		%	5	25	—	5	30	5	25
	77°C (170°F)		%	30	30	—	30	30	25	30
	121°C (250°F)		%	45	40	—	30	30	45	40
	Shear Strength	D 732	MPa	66.2	—	—	66.2	63.4	72.4	68.9
	23°C (73°F)		psi	9,600	—	—	9,600	9,200	10,500	10,000
STIFFNESS AND CREEP	Flexural Modulus									
	–40°C	D 790	MPa	3,241	3,447	—	3,241	3,447	3,516	—
	–40°F		psi	470,000	500,000	—	470,000	500,000	510,000	—
	23°C		MPa	2,827	1,207	2,760	2,827	1,207	2,964	1,310
	73°F		psi	410,000	175,000	400,000	410,000	175,000	430,000	190,000
	77°C		MPa	689	565	—	689	565	724	586
	170°F		psi	100,000	82,000	—	100,000	82,000	105,000	85,000
	121°C		MPa	538	414	—	538	414	552	—
	250°F		psi	78,000	60,000	—	78,000	60,000	80,000	—
	Compressive Stress at 1% Deformation	D 695	MPa	33.8	—	—	33.8	15.2	—	—
			psi	4,900	—	—	4,900	2,200	—	—
	Deformation Under Load									
	13.8 MPa 50°C 2,000 psi 122°F	D 621	%	1.4	—	—	—	—	1.2	—
	Heat Deflection Temp.									
	1.8 MPa	D 648	°C	90	—	90	90	—	90	—
	264 psi		°F	194	—	194	194	—	194	—
	0.5 MPa		°C	235	—	235	235	—	240	—
	66 psi		°F	455	—	455	455	—	464	—
TOUGHNESS	Brittleness Temp.	D 746	°C	–80	–65	—	–100	–85	–52	–52
			°F	–112	–85	—	–148	–121	–62	–62
	Izod Impact Strength									
	–40°C	D 256	J/m	32	27	—	32	27	37	32
	–40°F		ft lb/in	0.6	0.5	—	0.6	0.5	0.7	0.6
	23°C		J/m	53	112	≥53	64	133	43	107
	73°F		ft lb/in	1.0	2.1	≥1.0	1.2	2.5	0.8	2.0
	Tensile Impact Strength									
	Long Specimen									
	23°C	D 1822	kJ/m²	504	1,470	—	536	—	—	—
	73°F		ft lb/in²	240	700	—	255	—	—	—
	Short Specimen									
	23°C		kJ/m²	157	231	—	—	—	—	—
	73°F		ft lb/in²	75	110	—	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Nylon 66[a]						
				General Purpose		Fast Cycling	High Molecular Wt.		Weather Resistant	
				Zytel® 101 Zytel® 101L		Zytel® 101F	Zytel® 42A		Zytel® 105 BK010A	
				DAM	50% RH	DAM	DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C	262	—	262	262	—	262	—
			°F	504	—	504	504	—	504	—
	Coefficient of Linear Thermal Expansion[d]	D 696	10^{-4}/K	0.81	—	—	0.81	—	—	—
			10^{-4}/F	0.45	—	—	0.45	—	—	—
	Specific Heat		J/kg·K	2,750	—	2,750	2,750	—	2,750	—
			Btu/lb·F	0.65	—	0.65	0.65	—	0.65	—
	Thermal Conductivity[e]		W/m·K	0.25	—	—	0.25	—	0.25	—
			Btu-in/h ft²·°F	1.7	—	—	1.7	—	1.7	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	10^{15}	10^{13}	—	10^{15}	10^{13}	10^{14}	10^{12}
	Dielectric Constant	D 150								
	100 Hz			4.0	8.0	—	4.0	8.0	4.0	8.0
	10^3 Hz			3.9	7.0	—	3.9	7.0	3.9	7.0
	10^6 Hz			3.6	4.6	—	3.6	4.6	3.6	4.6
	Dissipation Factor									
	100 Hz			0.01	0.2	—	0.01	0.2	0.02	0.13
	10^3 Hz			0.02	0.2	—	0.02	0.2	0.03	0.12
	10^6 Hz			0.02	0.1	—	0.02	0.1	0.03	0.06
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 V-2		94 V-2	94 HB		94 V-2	
	Oxygen Index[g]	D 2863	%	28	31	—	—	—	25	31
MISCELLANEOUS	Specific Gravity	D 792		1.14	—	1.14	1.14	—	1.15	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	1.2	—	—	1.2	—	1.2	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	8.5	—	—	8.5	—	8.5	—
	Hardness Rockwell M	D 785		M79	M59	—	M80	M60	M87	M80
	Hardness Rockwell R	D 785		R121	R108	R121	R121	R108	R121	R109
	Durometer Hardness (D Scale)	D 676		89	82	—	—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	7	—	—	4	—	—
	Mold Shrinkage, flow for 3.2 mm (⅛ in) thick (approx.)		%	1.5	—	—	1.5	—	1.5	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6								
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures								
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes								

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (⅛ in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Nylon 66[a]					
				Hydrolysis Resistant	Nucleated Fast Cycling	Impact Modified		Super Tough	
				Zytel® 122L	Zytel® 132F	Zytel® 408L Zytel® 408HS		Zytel® ST801 Zytel® ST801HS	
				DAM	DAM	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength								
	–40°C	D 638	MPa	—	—	104.1	90.3	80.0	68.9
	–40°F		psi	—	—	15,100	13,100	11,600	10,000
	23°C		MPa	82.7	90	62.1	51.7	51.7	41.4
	73°F		psi	12,000	13,000	9,000	7,500	7,500	6,000
	77°C		MPa	—	—	43.4	34.5	40.7	—
	170°F		psi	—	—	6,300	5,000	5,900	—
	121°C		MPa	—	—	31.7	27.6	34.5	—
	250°F		psi	—	—	4,600	4,000	5,000	—
	Yield Strength								
	–40°C	D 638	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	—	—	60.7	51.7	—	—
	73°F		psi	—	—	8,800	7,500	—	—
	77°C		MPa	—	—	33.8	26.2	—	—
	170°F		psi	—	—	4,900	3,800	—	—
	121°C		MPa	—	—	22.8	20.7	—	—
	250°F		psi	—	—	3,300	3,000	—	—
	Elongation at Break								
	–40°C (–40°F)	D 638	%	—	—	—	20	20	10
	23°C (73°F)		%	50	25	80	270	60	210
	77°C (170°F)		%	—	—	210	≥300	220	170
	121°C (250°F)		%	—	—	≥300	≥300	275	—
	Elongation at Yield								
	–40°C (–40°F)	D 638	%	—	—	—	—	—	—
	23°C (73°F)		%	—	—	5	15	—	—
	77°C (170°F)		%	—	—	30	28	—	—
	121°C (250°F)		%	—	—	50	40	—	—
	Shear Strength	D 732	MPa	—	—	—	—	57.9	—
	23°C (73°F)		psi	—	—	—	—	8,400	—
STIFFNESS AND CREEP	Flexural Modulus								
	–40°C	D 790	MPa	—	—	2,827	3,309	1,965	2,344
	–40°F		psi	—	—	410,000	480,000	285,000	340,000
	23°C		MPa	2,827	3,100	1,965	1,103	1,689	862
	73°F		psi	410,000	450,00	285,000	160,000	245,000	125,000
	77°C		MPa	—	—	552	414	476	393
	170°F		psi	—	—	80,000	60,000	69,000	57,000
	121°C		MPa	—	—	345	345	345	324
	250°F		psi	—	—	50,000	50,000	50,000	47,000
	Compressive Stress at 1% Deformation	D 695	MPa	—	—	—	—	13.1	—
			psi	—	—	—	—	1,900	—
	Deformation Under Load 13.8 MPa 50°C 2,000 psi 122°F	D 621	%	—	—	1.4	—	—	—
	Heat Deflection Temp.[c]								
	1.8 MPa	D 648	°C	90	65*	75	—	71	—
	264 psi		°F	194	149*	167	—	160	—
	0.5 MPa		°C	235	235*	230	—	216	—
	66 psi		°F	455	455*	446	—	421	—
TOUGHNESS	Brittleness Temp.	D 746	°C	—	—	–104	–84	—	—
			°F	—	—	–155	–120	—	—
	Izod Impact Strength								
	–40°C	D 256	J/m	—	—	69	64	160	139
	–40°F		ft lb/in	—	—	1.3	1.2	3.0	2.6
	23°C		J/m	53	42.7	230	240	907	1,068
	73°F		ft lb/in	1.0	0.8	4.3	4.5	17	20
	Tensile Impact Strength Long Specimen								
	23°C	D 1822	kJ/m²	—	—	550	1,680	588	1,155
	73°F		ft lb/in²	—	—	262	800	280	550
	Short Specimen								
	23°C		kJ/m²	—	—	189	265	—	—
	73°F		ft lb/in²	—	—	90	126	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Nylon 66[a]					
				Hydrolysis Resistant	Nucleated Fast Cycling	Impact Modified		Super Tough	
				Zytel® 122L	Zytel® 132F	Zytel® 408L Zytel® 408HS		Zytel® ST801 Zytel® ST801HS	
				DAM	DAM	DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C °F	262 504	264 507	263 505	— —	263 505	— —
	Coefficient of Linear Thermal Expansion[d]	D 696	10^{-4}/K 10^{-4}/F	— —	— —	0.81 0.45	— —	1.2 0.67	— —
	Specific Heat			—	—	—	—	—	—
	Thermal Conductivity[e]		W/m·K Btu·in/h ft²·°F	— —	— —	— —	— —	— —	— —
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	—	—	10^{15}	10^{13}	10^{14}	10^{13}
	Dielectric Constant								
	100 Hz	D 150		—	—	3.1	5.9	3.2	5.5
	10^3 Hz			—	—	3.1	4.8	3.2	4.5
	10^6 Hz			—	—	2.9	3.3	2.9	3.2
	Dissipation Factor								
	100 Hz			—	—	0.02	0.1	0.01	0.2
	10^3 Hz			—	—	0.02	0.11	0.01	0.1
	10^6 Hz			—	—	0.02	0.10	0.02	0.05
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 HB	94 V-2	94 HB		94 HB	
	Oxygen Index[g]	D 2863	%	—	—	19	20	18	19
MISCELLANEOUS	Specific Gravity	D 792		1.14	1.14	1.09	—	1.08	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	—	—	1.2	—	1.2	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	—	—	7.0	—	6.7	—
	Hardness Rockwell M	D 785		—	—	M71	M50	—	—
	Hardness Rockwell R	D 785		122	—	R115	R102	R112	R89
	Durometer Hardness (D Scale)	D 676		—	—	83	76	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	—	—	—	—	7
	Mold Shrinkage, flow for 3.2 mm (⅛ in) thick (approx.)		%	—	—	1.5	—	1.8	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6							
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures							
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes							

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

[h] As molded, not annealed; applies to Zytel® 132F Heat Deflection Temperature on page 6.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[a]	ASTM Method	Unit	Nylon 612					
				Zytel® 151L		Zytel® 158L		Zytel® 153HSL	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength								
	–40°C	D 638	MPa	93.8	93.1	93.8	93.1	93.8	93.1
	–40°F		psi	13,600	13,500	13,500	13,500	13,600	13,500
	23°C		MPa	60.7	52.4	60.7	60.7	60.7	60.7
	73°F		psi	8,800	7,600	9,800	8,800	8,800	8,800
	77°C		MPa	40.7	36.5	40.7	29.6	40.7	—
	170°F		psi	5,900	5,300	5,900	5,300	5,900	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Yield Strength								
	–40°C	D 638	MPa	93.8	93.1	93.8	93.1	93.8	93.1
	–40°F		psi	13,600	13,500	13,600	13,500	13,600	13,500
	23°C		MPa	60.7	51.0	60.7	51.0	60.7	51.0
	73°F		psi	8,800	7,400	8,800	7,400	8,800	7,400
	77°C		MPa	29.7	35.2	29.6	35.2	29.6	—
	170°F		psi	4,300	5,100	4,300	5,100	4,300	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Elongation at Break								
	–40°C (–40°F)	D 638	%	10	20	15	30	15	30
	23°C (73°F)		%	100	250	150	≥300	150	≥300
	77°C (170°F)		%	230	≥300	≥300	≥300	—	—
	121°C (250°F)		%	—	—	—	—	—	—
	Elongation at Yield								
	–40°C (–40°F)	D 638	%	8	10	8	14	8	14
	23°C (73°F)		%	7	30	7	40	7	40
	77°C (170°F)		%	30	40	30	40	30	—
	121°C (250°F)		%	—	—	—	—	—	—
	Shear Strength	D 732	MPa	57.9	—	59.3	55.0	59.3	—
	23°C (73°F)		psi	8,400	—	8,600	8,100	8,600	—
STIFFNESS AND CREEP	Flexural Modulus								
	–40°C	D 790	MPa	2,344	2,758	2,344	2,758	2,344	2,758
	–40°F		psi	340,000	400,000	340,000	400,000	340,000	400,000
	23°C		MPa	2,034	1,241	2,034	1,241	2,034	1,241
	73°F		psi	295,000	180,000	295,000	180,000	295,000	180,000
	77°C		MPa	414	379	414	379	414	—
	170°F		psi	60,000	55,000	60,000	55,000	60,000	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Compressive Stress at 1% Deformation	D 695	MPa	16.5	—	16.6	—	16.6	—
			psi	2,400	—	2,400	—	2,400	—
	Deformation Under Load 13.8 MPa 50°C 2,000 psi 122°F	D 621	%	1.6	—	1.6	—	1.6	—
	Heat Deflection Temp.[c]								
	1.8 MPa	D 648	°C	90	—	90	—	90	—
	264 psi		°F	194	—	194	—	194	—
	0.5 MPa		°C	180	—	180	—	180	—
	66 psi		°F	356	—	356	—	356	—
TOUGHNESS	Brittleness Temp.	D 746	°C	–121	–107	–126	–109	–126	–109
			°F	–185	–160	–195	–165	–195	–165
	Izod Impact Strength								
	–40°C	D 256	J/m	32	21	48	32	43	32
	–40°F		ft lb/in	0.6	0.4	0.9	0.6	0.8	0.6
	23°C		J/m	43	69	53	75	53	75
	73°F		ft lb/in	0.8	1.3	1.0	1.4	1.0	1.4
	Tensile Impact Strength Long Specimen								
	23°C	D 1822	kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—
	Short Specimen								
	23°C		kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[a]	ASTM Method	Unit	Nylon 612					
				Zytel® 151L		Zytel® 158L		Zytel® 153 HSL	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C	217	—	217	—	217	—
			°F	423	—	423	—	423	—
	Coefficient of Linear Thermal Expansion[d]	D 696	m/m/°C	9×10^5	—	9×10^5	—	5×10^{-5}	—
			in/in/°F	5×10^5	—	5×10^5	—	5×10^{-5}	—
	Specific Heat		J/kg·K	2,660	—	2,660	—	2,660	—
			Btu/lb·F	0.63	—	0.63	—	0.63	—
	Thermal Conductivity[e]		W/m·K	0.22	—	0.22	—	0.22	—
			Btu·in/h ft²·°F	1.5	—	1.5	—	1.5	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	10^{15}	10^{13}	10^{15}	10^{13}	10^{14}	10^{13}
	Surface Resistivity	D 257	ohm-cm	—	—	—	—	10^{15}	10^{14}
	Dielectric Constant								
	100 Hz	D 150		4.0	6.0	4.0	6.0	3.9	—
	10^3 Hz			4.0	5.3	4.0	5.3	3.3	—
	10^6 Hz			3.5	4.0	3.5	4.0	3.0	—
	Dissipation Factor								
	100 Hz			0.02	0.15	0.02	0.15	0.02	—
	10^3 Hz			0.02	0.15	0.02	0.15	0.02	—
	10^6 Hz			0.02	0.10	0.02	0.10	0.02	—
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 V-2	94 V-2	94 V-2	94 V-2	94 V-2	94 V-2
	Oxygen Index[g]	D 2863	%	—	—	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.06	1.06	1.06	1.06	1.06	1.06
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	0.25	—	0.25	—	0.25	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	3.0	—	3.0	—	3.0	—
	Hardness Rockwell M	D 785		—	—	—	—	—	—
	Hardness Rockwell R	D 785		R 114	R 103	R 114	R 108	R 114	—
	Durometer Hardness (D Scale)	D 676		—	—	—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	6	—	6	—	6
	Mold Shrinkage, flow for 3.2 mm (⅛ in) thick (approx.)		%	1.3	—	1.1	—	1.1	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6							
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures							
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes							

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced Nylon 66					
				Zytel® 70G13L Zytel® 70G13HS1L		Zytel® 70G33L Zytel® 70G33HS1L Zytel® 70G33HRL		Zytel® 70G43L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength								
	–40°C	D 638	MPa	—	—	214	207	252	—
	–40°F		psi	—	—	31,000	30,000	36,500	—
	23°C		MPa	121	83	186	124	207	145
	73°F		psi	17,500	12,000	27,000	18,000	30,000	21,000
	77°C		MPa	—	—	110	86	121	72
	170°F		psi	—	—	16,000	12,500	17,500	10,500
	121°C		MPa	—	—	—	—	86	—
	250°F		psi	—	—	—	—	12,500	—
	Elongation at Break								
	–40°C (–40°F)	D 638	%	—	—	—	—	—	—
	23°C (73°F)		%	3	8	3	4	2	3
	77°C (170°F)		%	—	—	—	—	—	—
	121°C (250°F)		%	—	—	—	—	—	—
	Shear Strength	D 732	MPa	76	—	86	—	93	—
	23°C (73°F)		psi	11,000	—	12,500	—	13,500	—
STIFFNESS AND CREEP	Flexural Modulus								
	–40°C	D 790	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	4,826	2,758	8,963	6,205	11,032	8,274
	73°F		psi	700,000	400,000	1,300,000	900,000	1,600,000	1,200,000
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Flexural Strength	D790	MPa	165	—	262	—	285	—
	23°C (73°F)		psi	24,000	—	38,000	—	41,000	—
	Compressive	D 695	MPa	—	—	—	—	—	—
	Stress at 1%		psi	—	—	—	—	—	—
	Deformation								
	Deformation								
	Under Load								
	27.6 MPa 50°C	D 621	%	1.1	—	0.8	—	0.7	—
	4,000 psi 122°F								
	Heat Deflection Temp.								
	1.8 MPa	D 648	°C	243	—	249	—	252	—
	264 psi		°F	470	—	480	—	485	—
	0.5 MPa		°C	—	—	260	—	260	—
	66 psi		°F	—	—	500	—	500	—
TOUGHNESS	Izod Impact Strength								
	–40°C	D 256	J/m	—	—	—	—	—	—
	–40°F		ft lb/in	—	—	—	—	—	—
	23°C		J/m	48	53	117	133	133	187
	73°F		ft lb/in	0.9	1.0	2.2	2.5	2.5	3.5
	Tensile Impact Strength								
	Long Specimen								
	23°C	D 1822	kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—
	Short Specimen								
	23°C		kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced Nylon 66					
				Zytel® 70G13L Zytel® 70G13HS1L		Zytel® 70G33L Zytel® 70G33HS1L Zytel® 70G33HRL		Zytel® 70G43L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C	262	—	262	—	262	—
			°F	504	—	504	—	504	—
	Coefficient of Linear Thermal Expansion[d]	D 696	10^{-4}/K	0.27	—	0.23	—	0.22	—
			10^{-4}/F	0.15	—	0.13	—	0.12	—
	Specific Heat			—	—	—	—	—	—
	Thermal Conductivity[e]		W/m·K	—	—	—	—	—	—
			Btu·in/h ft²·°F	—	—	—	—	—	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	—	—	10^{15}	—	—	—
	Dielectric Constant	D 150							
	100 Hz			—	—	—	—	—	—
	10^3 Hz			—	—	4.5	—	—	—
	10^6 Hz			—	—	3.7	—	—	—
	Dissipation Factor								
	100 Hz			—	—	—	—	—	—
	10^3 Hz			—	—	0.02	—	—	—
	10^6 Hz			—	—	0.02	—	—	—
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 HB		94 HB		94 HB	
	Oxygen Index[g]	D 2863	%	—	—	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.22	—	1.38	—	1.51	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	—	—	0.7	—	0.6	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	7.1	—	5.4	—	4.7	—
	Hardness Rockwell M	D 785		M95	M84	M101	—	M103	—
	Hardness Rockwell R	D 785		R122	R113	—	—	—	—
	Durometer Hardness (D Scale)	D 676		—	—	—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	12	—	14	—	—
	Mold Shrinkage, flow for 3.2 mm (⅛ in) thick (approx.)		%	0.5	—	0.2	—	0.2	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6							
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures							
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes							

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced, Impact Modified			
				Zytel® 71G13L, Zytel® 71G13HS1L		Zytel® 71G33L	
				DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength						
	–40°C	D 638	MPa	—	—	—	—
	–40°F		psi	—	—	—	—
	23°C		MPa	103	62	152	110
	73°F		psi	15,000	9,000	22,000	16,000
	77°C		MPa	—	—	—	—
	170°F		psi	—	—	—	—
	121°C		MPa	—	—	—	—
	250°F		psi	—	—	—	—
	Elongation at Break						
	–40°C (–40°F)	D 638	%	—	—	—	—
	23°C (73°F)		%	4	11	3	4
	77°C (170°F)		%	—	—	—	—
	121°C (250°F)		%	—	—	—	—
	Shear Strength	D 732	MPa	62	—	72	—
	23°C (73°F)		psi	9,000	—	10,500	—
STIFFNESS AND CREEP	Flexural Modulus						
	–40°C	D 790	MPa	—	—	—	—
	–40°F		psi	—	—	—	—
	23°C		MPa	3,792	2,068	6,895	5,516
	73°F		psi	550,000	300,000	1,000,000	800,000
	77°C		MPa	—	—	—	—
	170°F		psi	—	—	—	—
	121°C		MPa	—	—	—	—
	250°F		psi	—	—	—	—
	Flexural Strength	D 790	MPa	145	—	228	—
	23°C (73°F)		psi	21,000	—	33,000	—
	Compressive	D 695	MPa	—	—	—	—
	Stress at 1% Deformation		psi	—	—	—	—
	Deformation Under Load						
	27.6 MPa 50°C	D 621	%	1.7	—	1.3	—
	4,000 psi 122°F						
	Heat Deflection Temp.						
	1.8 MPa	D 648	°C	232	—	246	—
	264 psi		°F	450	—	475	—
	0.5 MPa		°C	255	—	260	—
	66 psi		°F	491	—	500	—
TOUGHNESS	Izod Impact Strength						
	–40°C	D 256	J/m	—	—	—	—
	–40°F		ft lb/in	—	—	—	—
	23°C		J/m	123	123	128	128
	73°F		ft lb/in	2.3	2.3	2.4	2.4
	Tensile Impact Strength Long Specimen						
	23°C	D 1822	kJ/m²	—	—	—	—
	73°F		ft lb/in²	—	—	—	—
	Short Specimen						
	23°C		kJ/m²	—	—	—	—
	73°F		ft lb/in²	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins*(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced, Impact Modified: Zytel® 71G13L / Zytel® 71G13HS1L — DAM	Zytel® 71G13L / Zytel® 71G13HS1L — 50% RH	Zytel® 71G33L — DAM	Zytel® 71G33L — 50% RH
THERMAL	Melting Point	D 3418	°C	262	—	262	—
			°F	504	—	504	—
	Coefficient of Linear Thermal Expansion[d]	D 696	10^{-4}/K	0.23	—	0.18	—
			10^{-4}/F	0.13	—	0.10	—
	Specific Heat			—	—	—	—
	Thermal Conductivity[e]		W/m·K	—	—	—	—
			Btu·in/h ft²·°F	—	—	—	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	10^{14}	10^{9}	10^{14}	10^{9}
	Dielectric Constant	D 150					
	100 Hz			—	—	—	—
	10^{3} Hz			—	—	4.2	—
	10^{6} Hz			—	—	3.4	—
	Dissipation Factor						
	100 Hz			—	—	—	—
	10^{3} Hz			—	—	0.02	—
	10^{6} Hz			—	—	0.02	—
FLAMMABILITY	UL Flammability (Class)[f,g]		UL 94	94 HB		94 HB	
	Oxygen Index[g]	D 2863	%	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.18	—	1.35	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	—	—	0.5	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	6.1	—	4.6	—
	Hardness Rockwell M	D 785		M82	M66	M96	M90
	Hardness Rockwell R	D 785		R117	R110	R122	R118
	Durometer Hardness (D Scale)	D 676		—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	34	—	36
	Mold Shrinkage, flow for 3.2 mm (⅛ in) thick (approx.)		%	0.6	—	0.3	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6					
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures					
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes					

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced Nylon Copolymers					
				Zytel® 72G13L Zytel® 72G13HS1L		Zytel® 72G33L		Zytel® 72G43L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength								
	–40°C	D 638	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	110	—	186	130	207	145
	73°F		psi	16,000	—	27,000	19,000	30,000	21,000
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Elongation at Break								
	–40°C (–40°F)	D 638	%	—	—	—	—	—	—
	23°C (73°F)		%	2.8	—	4	7	3	6
	77°C (170°F)		%	—	—	—	—	—	—
	121°C (250°F)		%	—	—	—	—	—	—
	Shear Strength	D 732	MPa	—	—	—	—	—	—
	23°C (73°F)		psi	—	—	—	—	—	—
STIFFNESS AND CREEP	Flexural Modulus								
	–40°C	D 790	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	4,830	—	8,965	5,515	11,032	7,584
	73°F		psi	700,000	—	1,300,000	800,000	1,600,000	1,100,000
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Flexural Strength	D 790	MPa	170	—	286	—	300	—
	23°C (73°F)		psi	25,000	—	41,500	—	43,000	—
	Compressive Stress at 1% Deformation	D 695	MPa	—	—	—	—	—	—
			psi	—	—	—	—	—	—
	Deformation Under Load 27.6 MPa 50°C 4,000 psi 122°F	D 621	%	—	—	—	—	—	—
	Heat Deflection Temp.								
	1.8 MPa	D 648	°C	210	—	224	—	224	—
	264 psi		°F	410	—	436	—	435	—
	0.5 MPa		°C	—	—	—	—	—	—
	66 psi		°F	—	—	—	—	—	—
TOUGHNESS	Izod Impact Strength								
	–40°C	D 256	J/m	—	—	—	—	—	—
	–40°F		ft lb/in	—	—	—	—	—	—
	23°C		J/m	48	—	123	164	159	212
	73°F		ft lb/in	0.9	—	2.3	3.1	3	4
	Unnotched Impact 23°C	D 4812	J/m	426	—	1,330	—	—	—
	73°F		ft lb/in	8	—	25	—	—	—
	Tensile Impact Strength Long Specimen								
	23°C	D 1822	kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—
	Short Specimen								
	23°C		kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[a]	ASTM Method	Unit	Glass-Reinforced Nylon Copolymers					
				Zytel® 72G13L Zytel® 72G13HS1L		Zytel® 72G33L		Zytel® 72G43L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C	238	—	238	—	233	—
			°F	460	—	460	—	451	—
	Coefficient of Linear Thermal Expansion[d]	D 696	m/m/°C	—	—	—	—	—	—
			in/in/°F	—	—	—	—	—	—
	Specific Heat			—	—	—	—	—	—
	Thermal Conductivity[e]		W/m·K	—	—	—	—	—	—
			Btu·in/h ft²·°F	—	—	—	—	—	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	—	—	—	—	—	—
	Dielectric Constant								
	100 Hz	D 150		—	—	—	—	—	—
	10^3 Hz			—	—	—	—	—	—
	10^6 Hz			—	—	—	—	—	—
	Dissipation Factor								
	100 Hz			—	—	—	—	—	—
	10^3 Hz			—	—	—	—	—	—
	10^6 Hz			—	—	—	—	—	—
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 HB*		94 HB		94 HB	
	Oxygen Index[g]	D 2863	%	—	—	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.22	—	1.38	—	1.50	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	—	—	—	—	—	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	—	—	—	—	—	—
	Hardness Rockwell M	D 785		—	—	—	—	—	—
	Hardness Rockwell R	D 785		—	—	—	—	—	—
	Durometer Hardness (D Scale)	D 676		—	—	—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	—	—	—	—	—
	Mold Shrinkage 3.2 mm (⅛ in) thickness:								
	Flow	D955	%	—	—	0.3	—	0.2	—
	Transverse		%	—	—	1.0	—	—	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6							
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures							
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes							

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

[*] UL 94 HB rating only applicable to Zytel® 72G13HS1L.

Table 2
Properties of Zytel® Nylon Resins*(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced, Improved Surface					
				Zytel® 74G13L		Zytel® 74G33L		Zytel® 74G43L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength								
	–40°C	D 638	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	120	—	186	121	207	—
	73°F		psi	17,500	—	27,000	17,500	30,000	—
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Elongation at Break								
	–40°C (–40°F)	D 638	%	—	—	—	—	—	—
	23°C (73°F)		%	3	—	4	7	3	4
	77°C (170°F)		%	—	—	—	—	—	—
	121°C (250°F)		%	—	—	—	—	—	—
	Shear Strength								
	23°C (73°F)	D 732	MPa	—	—	—	—	—	—
			psi	—	—	—	—	—	—
STIFFNESS AND CREEP	Flexural Modulus								
	–40°C	D 790	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	4,830	—	8,965	4,830	11,720	—
	73°F		psi	700,000	—	1,300,000	700,000	1,700,000	—
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Flexural Strength	D 790	MPa	—	—	290	—	338	—
	23°C (73°F)		psi	—	—	42,000	—	49,000	—
	Compressive Stress at 1% Deformation	D 695	MPa	—	—	—	—	—	—
			psi	—	—	—	—	—	—
	Deformation Under Load								
	27.6 MPa 50°C 4,000 psi 122°F	D 621	%	—	—	—	—	—	—
	Heat Deflection Temp.								
	1.8 MPa	D 648	°C	220	—	225	—	235	—
	264 psi		°F	428	—	437	—	455	—
	0.5 MPa		°C	—	—	245	—	—	—
	66 psi		°F	—	—	473	—	—	—
TOUGHNESS	Izod Impact Strength								
	–40°C	D 256	J/m	—	—	—	—	—	—
	–40°F		ft lb/in	—	—	—	—	—	—
	23°C		J/m	48	—	135	185	187	—
	73°F		ft lb/in	0.9	—	2.5	3.5	3.5	—
	Unnotched Impact 23°C	D 4812	J/m	640	—	1,330	1,385	1,600	—
	73°F		ft lb/in	12	—	25	26	30	—
	Tensile Impact Strength Long Specimen								
	23°C	D 1822	kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—
	Short Specimen								
	23°C		kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced, Improved Surface: Zytel® 74G13L DAM	Zytel® 74G13L 50% RH	Zytel® 74G33L DAM	Zytel® 74G33L 50% RH	Zytel® 74G43L DAM	Zytel® 74G43L 50% RH
THERMAL	Melting Point	D 3418	°C	259	—	259	—	259	—
			°F	498	—	498	—	498	—
	Coefficient of Linear Thermal Expansion[d]	D 696	m/m/°C	—	—	—	—	—	—
			in/in/°F	—	—	—	—	—	—
	Specific Heat			—	—	—	—	—	—
	Thermal Conductivity[e]		W/m·K	—	—	—	—	—	—
			Btu·in/h ft²·°F	—	—	—	—	—	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	—	—	—	—	—	—
	Dielectric Constant								
	100 Hz	D 150		—	—	—	—	—	—
	10^3 Hz			—	—	—	—	—	—
	10^6 Hz			—	—	—	—	—	—
	Dissipation Factor								
	100 Hz			—	—	—	—	—	—
	10^3 Hz			—	—	—	—	—	—
	10^6 Hz			—	—	—	—	—	—
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		—	—	94 HB		—	—
	Oxygen Index[g]	D 2863	%	—	—	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.22	—	1.39	—	1.49	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	—	—	—	—	—	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	—	—	—	—	—	—
	Hardness Rockwell M	D 785		—	—	—	—	—	—
	Hardness Rockwell R	D 785		—	—	—	—	—	—
	Durometer Hardness (D Scale)	D 676		—	—	—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	—	—	—	—	—
	Mold Shrinkage 3.2 mm (⅛ in) thickness								
	Flow	D 955	%	—	—	0.2	—	—	—
	Transverse		%	—	—	1.0	—	—	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6							
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures							
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes							

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced Nylon 612			
				Zytel® 77G33L Zytel® 77G33HS1L		Zytel® 77G43L	
				DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength						
	–40°C	D 638	MPa	235	—	—	—
	–40°F		psi	34,000	—	—	—
	23°C		MPa	165	138	193	166
	73°F		psi	24,000	20,000	28,000	24,000
	77°C		MPa	110	97	—	—
	170°F		psi	16,000	14,000	—	—
	121°C		MPa	75	—	—	—
	250°F		psi	11,000	—	—	—
	Elongation at Break						
	–40°C (–40°F)	D 638	%	—	—	—	—
	23°C (73°F)		%	3	4	3	5
	77°C (170°F)		%	—	—	—	—
	121°C (250°F)		%	—	—	—	—
	Shear Strength	D 732	MPa	76	—	83	—
	23°C (73°F)		psi	11,000	—	12,000	—
STIFFNESS AND CREEP	Flexural Modulus						
	–40°C	D 790	MPa	—	—	—	—
	–40°F		psi	—	—	—	—
	23°C		MPa	8,274	6,205	10,342	8,618
	73°F		psi	1,200,000	900,000	1,500,000	1,250,000
	77°C		MPa	—	—	—	—
	170°F		psi	—	—	—	—
	121°C		MPa	—	—	—	—
	250°F		psi	—	—	—	—
	Flexural Strength	D 790	MPa	255	—	269	—
	23°C (73°F)		psi	37,000	—	39,000	—
	Compressive	D 695	MPa	—	—	—	—
	Stress at 1%		psi	—	—	—	—
	Deformation						
	Deformation						
	Under Load						
	27.6 MPa 50°C	D 621	%	1.0	—	0.5	—
	4,000 psi 122°F						
	Heat Deflection Temp.						
	1.8 MPa	D 648	°C	210	—	210	—
	27.6 psi		°F	410	—	410	—
	0.5 MPa		°C	—	—	—	—
	66 psi		°F	—	—	—	—
TOUGHNESS	Izod Impact Strength						
	–40°C	D 256	J/m	—	—	—	—
	–40°F		ft lb/in	—	—	—	—
	23°C		J/m	128	133	155	160
	73°F		ft lb/in	2.4	2.5	2.9	3.0
	Tensile Impact Strength						
	Long Specimen						
	23°C	D 1822	kJ/m²	—	—	—	—
	73°F		ft lb/in²	—	—	—	—
	Short Specimen						
	23°C		kJ/m²	—	—	—	—
	73°F		ft lb/in²	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced Nylon 612			
				Zytel® 77G33L, Zytel® 77G33HS1L		Zytel® 77G43L	
				DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C	217	—	217	—
			°F	423	—	423	—
	Coefficient of Linear Thermal Expansion[d]	D 696	10^{-4}/K	0.23	—	0.22	—
			10^{-4}/F	0.13	—	0.12	—
	Specific Heat			—	—	—	—
	Thermal Conductivity[e]		W/m·K	—	—	—	—
			Btu·in/h ft²·°F	—	—	—	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	10^{15}	10^{12}	10^{15}	10^{12}
	Dielectric Constant	D 150					
	100 Hz			—	—	—	—
	10^3 Hz			3.7	—	4.0	—
	10^6 Hz			3.4	—	3.6	—
	Dissipation Factor						
	100 Hz			—	—	—	—
	10^3 Hz			0.02	—	0.03	—
	10^6 Hz			0.02	—	0.02	—
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 HB*		94 HB	
	Oxygen Index[g]	D 2863	%	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.32	—	1.42	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	0.16	—	0.14	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	2.0	—	1.7	—
	Hardness Rockwell M	D 785		—	—	—	—
	Hardness Rockwell R	D 785		R118	—	R118	—
	Durometer Hardness (D Scale)	D 676		—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	—	—	—
	Mold Shrinkage, flow for 3.2 mm (⅛ in) thick (approx.)		%	0.2	—	0.1	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6					
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures					
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes					

(continued)

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel® 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

[b] Properties are measured DAM (dry as molded, with about 0.2% water) or at 50% RH (i.e., equilibrated with the atmosphere at 50% relative humidity). These values are for natural color (NC010) resins only.

[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

[*] UL 94 HB rating only applicable to Zytel® 77G33L.

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced					
				Toughened Nylon 66				Toughened Copolymer	
				Zytel® 8018 Zytel® 8018HS		Zytel® 80G33L Zytel® 80G33HS1L		Zytel® 82G33L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
STRENGTH	Tensile Strength								
	–40°C	D 638	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	90	60	145	110	153	110
	73°F		psi	12,900	8,700	21,000	16,000	22,200	16,000
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Elongation at Break								
	–40°C (–40°F)	D 638	%	—	—	—	—	—	—
	23°C (73°F)		%	6	14	4	5	4	8
	77°C (170°F)		%	—	—	—	—	—	—
	121°C (250°F)		%	—	—	—	—	—	—
	Shear Strength	D 732	MPa	—	—	—	—	—	—
	23°C (73°F)		psi	—	—	—	—	—	—
STIFFNESS AND CREEP	Flexural Modulus								
	–40°C	D 790	MPa	—	—	—	—	—	—
	–40°F		psi	—	—	—	—	—	—
	23°C		MPa	3,660	2,200	6,895	5,068	7,585	4,480
	73°F		psi	530,000	320,000	1,000,000	735,000	1,100,000	650,000
	77°C		MPa	—	—	—	—	—	—
	170°F		psi	—	—	—	—	—	—
	121°C		MPa	—	—	—	—	—	—
	250°F		psi	—	—	—	—	—	—
	Flexural Strength	D 790	MPa	—	—	206	—	230	—
	23°C (73°F)		psi	—	—	29,800	—	33,500	—
	Compressive	D 790	MPa	—	—	165	—	—	—
	Strength		psi	—	—	24,000	—	—	—
	Compressive	D 695	MPa	—	—	—	—	—	—
	Stress at 1%		psi	—	—	—	—	—	—
	Deformation								
	Deformation Under Load								
	27.6 MPa 50°C	D 621	%	—	—	—	—	—	—
	4,000 psi 122°F								
	Heat Deflection Temp.								
	1.8 MPa	D 648	°C	220	—	250	—	220	—
	264 psi		°F	428	—	482	—	428	—
	0.5 MPa		°C	250	—	—	—	—	—
	66 psi		°F	482	—	—	—	—	—
TOUGHNESS	Izod Impact Strength								
	–40°C	D 256	J/m	—	—	—	—	—	—
	–40°F		ft lb/in	—	—	—	—	—	—
	23°C		J/m	140	215	219	235	225	288
	73°F		ft lb/in	2.6	4.0	4.1	4.4	4.2	5.4
	Unnotched Impact 23°C	D 4812	J/m	960	1,065	—	—	—	—
	73°F		ft lb/in	18	20	—	—	—	—
	Tensile Impact Strength Long Specimen								
	23°C	D 1822	kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—
	Short Specimen								
	23°C		kJ/m²	—	—	—	—	—	—
	73°F		ft lb/in²	—	—	—	—	—	—

(continued)

Table 2
Properties of Zytel® Nylon Resins *(continued)*

	Property[b]	ASTM Method	Unit	Glass-Reinforced					
				Toughened Nylon 66				Toughened Copolymer	
				Zytel® 8018 Zytel® 8018HS		Zytel® 80G33L Zytel® 80G33HS1L		Zytel® 82G33L	
				DAM	50% RH	DAM	50% RH	DAM	50% RH
THERMAL	Melting Point	D 3418	°C	262	—	255	—	233	—
			°F	504	—	491	—	451	—
	Coefficient of Linear Thermal Expansion[d]	D 696	10^{-4}/K	—	—	—	—	—	—
			10^{-4}/F	—	—	—	—	—	—
	Specific Heat			—	—	—	—	—	—
	Thermal Conductivity[e]		W/m·K	—	—	—	—	—	—
			Btu·in/h ft²·°F	—	—	—	—	—	—
ELECTRICAL	Volume Resistivity	D 257	ohm-cm	—	—	—	—	—	—
	Dielectric Constant								
	100 Hz	D 150		—	—	—	—	—	—
	10^3 Hz			—	—	—	—	—	—
	10^6 Hz			—	—	—	—	—	—
	Dissipation Factor								
	100 Hz			—	—	—	—	—	—
	10^3 Hz			—	—	—	—	—	—
	10^6 Hz			—	—	—	—	—	—
FLAMMABILITY	UL Flammability (Class)[f,g]	UL 94		94 HB		94 HB		94 HB	
	Oxygen Index[g]	D 2863	%	—	—	—	—	—	—
MISCELLANEOUS	Specific Gravity	D 792		1.19	—	1.34	—	1.34	—
	Water Absorption 24-hr immersion 23°C (73°F)	D 570	%	—	—	—	—	—	—
	Water Absorption Saturation 23°C (73°F)	D 570	%	—	—	—	—	—	—
	Hardness Rockwell M	D 785		—	—	—	—	—	—
	Hardness Rockwell R	D 785		—	—	—	—	—	—
	Durometer Hardness (D Scale)	D 676		—	—	—	—	—	—
	Taber Abrasion CS-17 Wheel, 1000 g		mg/1000 cycles	—	—	—	—	—	—
	Mold Shrinkage 3.2 mm (⅛ in) thickness								
	Flow	D 955	%	—	—	0.3	—	0.2	—
	Transverse		%	—	—	1.1	—	0.9	—
CHEMICAL	Acid Resistance	Limited; attacked by strong acids; general order of resistance 612>66>copolymers or 6							
	Base Resistance	Excellent at room temperature; attacked by strong bases at elevated temperatures							
	Solvent Resistance	Generally excellent; some absorption of such polar solvents as water, alcohols, and certain halogenated hydrocarbons causing plasticization and dimension changes							

[a] Many modified nylon 66 grades are similar in most properties to the unmodified resins. These include the hydrolysis-resistant Zytel® 122L, which has about 2–4 times the life in boiling water of the unstabilized resins. The heat-stabilized Zytel® 103HSL has mechanical properties similar to Zytel 101, except for slightly lower elongation. The internally lubricated Zytel® 101F offers optimum injection molding productivity.

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[c] These values obtained by first annealing the test bars for 30 min in oil at 50°C (90°F) below melting point of resin.

[d] These are approximate values. The coefficient of expansion is highly dependent on both temperature and moisture content.

[e] Thermal conductivity measured by Conco-Fitch apparatus.

[f] Based on specimens 1.6 mm (1/16 in) thick.

[g] This small scale test does not indicate combustion characteristics under actual fire conditions.

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MatWeb, The Online Materials Database

Overview - Nylon 6, Unreinforced

Subcategory: Nylon; Nylon 6; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 6; PA6; PA 6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1 - 1.17 g/cc	0.0361 - 0.0423 lb/in³	Average = 1.12 g/cc; Grade Count = 168
Apparent Bulk Density	0.65 g/cc	0.0235 lb/in³	Grade Count=1
Water Absorption	0.3 - 10 %	0.3 - 10 %	Average = 3.1%; Grade Count = 102
Moisture Absorption at Equilibrium	1.3 - 3.5 %	1.3 - 3.5 %	Average = 2.5%; Grade Count = 66
Water Absorption at Saturation	6 - 10.7 %	6 - 10.7 %	Average = 9.4%; Grade Count = 32
Linear Mold Shrinkage	0.003 - 0.0185 cm/cm	0.003 - 0.0185 in/in	Average = 0.012 cm/cm; Grade Count = 74
Linear Mold Shrinkage, Transverse	0.012 - 0.015 cm/cm	0.012 - 0.015 in/in	Average = 0.014 cm/cm; Grade Count = 14
Melt Flow	4 - 130 g/10 min	4 - 130 g/10 min	Average = 23.1 g/10 min; Grade Count = 19
Mechanical Properties			
Hardness, Rockwell M	55 - 88	55 - 88	Average = 74.4; Grade Count = 11
Hardness, Rockwell R	78 - 120	78 - 120	Average = 110; Grade Count = 37

Tensile Strength, Ultimate	48 - 100 MPa	6960 - 14500 psi	Average = 72.6 MPa; Grade Count = 50
Tensile Strength, Yield	20 - 95 MPa	2900 - 13800 psi	Average = 62.4 MPa; Grade Count = 122
Elongation at Break	7 - 460 %	7 - 460 %	Average = 93.8%; Grade Count = 154
Elongation at Yield	3.4 - 140 %	3.4 - 140 %	Average = 18.5%; Grade Count = 72
Tensile Modulus	0.3 - 4 GPa	43.5 - 580 ksi	Average = 1.9 GPa; Grade Count = 78
Flexural Modulus	0.1 - 3.4 GPa	14.5 - 493 ksi	Average = 2 GPa; Grade Count = 83
Flexural Yield Strength	28 - 130 MPa	4060 - 18900 psi	Average = 85.8 MPa; Grade Count = 66
Compressive Yield Strength	10 - 83 MPa	1450 - 12000 psi	Average = 28.9 MPa; Grade Count=13
Poisson's Ratio	0.35	0.35	Grade Count = 7
Shear Strength	59 MPa	8560 psi	Grade Count = 4
Secant Modulus	0.65 GPa	94.3 ksi	Grade Count = 1
Izod Impact, Notched	0.37 - NB	0.693 - NB	Average = 2.5 J/cm (NB computed as 15 J/cm); Grade Count = 97
Izod Impact, Notched Low Temp	0.16 - 2.1 J/cm	0.3 - 3.93 ft-lb/in	Average = 0.47 J/cm; Grade Count = 7
Charpy Impact, Unnotched	10 - NB	47.6 - NB	Average = 19.8 J/cm² (NB computed as 20 J/cm²); Grade Count = 42
Charpy Impact, Notched Low Temp	0.7 - 9.5 J/cm²	3.33 - 45.2 ft-lb/in²	Average = 5.2 J/cm²; Grade Count = 4
Charpy Impact, Unnotched Low Temp	1 - NB	4.76 - NB	Average = 16.2 J/cm² (NB computed as 20 J/cm²); Grade Count = 18
Charpy Impact, Notched	0 - 12 J/cm²	0 - 57.1 ft-lb/in²	Average = 5.2 J/cm²; Grade Count = 42
Tensile Impact Strength	2000 kJ/m²	952 ft-lb/in²	Grade Count = 3
Tensile Creep Modulus, 1 hour	900 - 2030 MPa	131000 - 294000 psi	Average = 1300 MPa; Grade Count = 11
Tensile Creep Modulus, 1000 hours	7 - 1100 MPa	1020 - 160000 psi	Average = 450 MPa; Grade Count = 30

Electrical Properties

Electrical Resistivity	1e+011 - 1e+015 ohm-cm	1e+011 - 1e+015 ohm-cm	Average = 3E+14 ohm-cm; Grade Count = 78
Surface Resistance	1e+010 - 1e+015 ohm	1e+010 - 1e+015 ohm	Average = 1E+14 ohm ohm; Grade Count = 69
Dielectric Constant	3 - 7	3 - 7	Average = 4.3; Grade Count = 83
Dielectric Constant, Low Frequency	2.5 - 16	2.5 - 16	Average = 5.5; Grade Count = 48
Dielectric Strength	14 - 100 kV/mm	356 - 2540 kV/in	Average = 36.4 kV/mm; Grade Count = 66
Dissipation Factor	0.002 - 0.4	0.002 - 0.4	Average = 0.12; Grade Count = 69
Dissipation Factor, Low Frequency	0.002 - 2.8	0.002 - 2.8	Average = 0.29; Grade Count = 44

Arc Resistance	118 - 125 sec	118 - 125 sec	Average = 120 sec; Grade Count=12
Comparative Tracking Index	500 - 600 V	500 - 600 V	Average = 600 V; Grade Count=41
Hot Wire Ignition, HWI	15 sec	15 sec	Grade Count = 4
High Amp Arc Ignition, HAI	120 arcs	120 arcs	Grade Count = 4

Thermal Properties

CTE, linear 20°C	70 - 200 µm/m-°C	38.9 - 111 µin/in-°F	Average = 91.1 µm/m-°C; Grade Count=57
CTE, linear 20°C Transverse to Flow	100 - 200 µm/m-°C	55.6 - 111 µin/in-°F	Average = 140 µm/m-°C; Grade Count=11
CTE, linear 100°C	90 - 105 µm/m-°C	50 - 58.3 µin/in-°F	Average = 92.9 µm/m-°C; Grade Count=14
Specific Heat Capacity	1.6 J/g-°C	0.382 BTU/lb-°F	Grade Count = 1
Thermal Conductivity	0.17 - 0.3 W/m-K	1.18 - 2.08 BTU-in/hr-ft²-°F	Average = 0.27 W/m-K; Grade Count = 16
Melting Point	193 - 255 °C	379 - 491 °F	Average = 220°C; Grade Count = 116
Maximum Service Temperature, Air	40 - 230 °C	104 - 446 °F	Average = 100°C; Grade Count = 106
Deflection Temperature at 0.46 MPa (66 psi)	50 - 198 °C	122 - 388 °F	Average = 160°C; Grade Count=85
Deflection Temperature at 1.8 MPa (264 psi)	40 - 230 °C	104 - 446 °F	Average = 66.7°C; Grade Count=106
Vicat Softening Point	80 - 204 °C	176 - 399 °F	Average = 170°C; Grade Count = 22
Minimum Service Temperature, Air	-40 - -20 °C	-40 - -4 °F	Average = -30°C; Grade Count = 14
Glass Temperature	60 °C	140 °F	Grade Count = 1
UL RTI, Electrical	65 - 105 °C	149 - 221 °F	Average = 91.7°C; Grade Count = 6
UL RTI, Mechanical with Impact	65 °C	149 °F	Grade Count = 6
UL RTI, Mechanical without Impact	65 - 75 °C	149 - 167 °F	Average = 71.7°C; Grade Count = 6
Flammability, UL94	HB	HB	Grade Count = 56
Oxygen Index	25 - 26 %	25 - 26 %	Average = 25.4%; Grade Count = 18

Processing Properties

Processing Temperature	230 - 335 °C	446 - 635 °F	Average = 260°C; Grade Count = 33
Rear Barrel Temperature	225 - 231 °C	437 - 448 °F	Average = 230°C; Grade Count = 3
Middle Barrel Temperature	230 - 235 °C	446 - 455 °F	Average = 230°C; Grade Count = 3
Front Barrel Temperature	240 °C	464 °F	Grade Count = 3
Nozzle Temperature	240 °C	464 °F	Grade Count = 2
Mold Temperature	52 - 82 °C	126 - 180 °F	Average = 73.2°C; Grade Count = 8

Drying Temperature	82 - 85 °C	180 - 185 °F	Average = 84.7°C; Grade Count = 20

MatWeb, The Online Materials Database

Overview - Nylon 6, 30% Mineral Filled

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 6; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 6; PA6; PA 6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.27 - 1.51 g/cc	0.0459 - 0.0546 lb/in³	Average = 1.39 g/cc; Grade Count = 25
Water Absorption	0.8 - 6.6 %	0.8 - 6.6 %	Average = 3.2%; Grade Count = 17
Moisture Absorption at Equilibrium	1 - 2.4 %	1 - 2.4 %	Average = 2%; Grade Count = 12
Water Absorption at Saturation	2.1 - 6.4 %	2.1 - 6.4 %	Average = 5.7%; Grade Count = 8
Linear Mold Shrinkage	0.007 - 0.012 cm/cm	0.007 - 0.012 in/in	Average = 0.00979 cm/cm; Grade Count = 14
Linear Mold Shrinkage, Transverse	0.008 - 0.012 cm/cm	0.008 - 0.012 in/in	Average = 0.011 cm/cm; Grade Count = 8
Melt Flow	6 - 80 g/10 min	6 - 80 g/10 min	Average = 51.5 g/10 min; Grade Count = 4
Mechanical Properties			
Hardness, Rockwell M	55 - 90	55 - 90	Average = 72.5; Grade Count = 2
Hardness, Rockwell R	105 - 120	105 - 120	Average = 120; Grade Count = 4
Tensile Strength, Ultimate	25 - 80 MPa	3630 - 11600 psi	Average = 59 MPa; Grade Count = 16

Tensile Strength, Yield	50 - 90 MPa	7250 - 13100 psi	Average = 66 MPa; Grade Count = 8
Elongation at Break	2.6 - 50 %	2.6 - 50 %	Average = 18.8%; Grade Count = 24
Tensile Modulus	1.6 - 7.1 GPa	232 - 1030 ksi	Average = 4 GPa; Grade Count = 17
Flexural Modulus	1.8 - 6 GPa	261 - 870 ksi	Average = 3.9 GPa; Grade Count = 11
Flexural Yield Strength	60 - 147 MPa	8700 - 21300 psi	Average = 110 MPa; Grade Count = 13
Compressive Yield Strength	17 - 29 MPa	2470 - 4210 psi	Average = 23 MPa; Grade Count=2
Poisson's Ratio	0.35	0.35	Grade Count = 1
Shear Strength	71 MPa	10300 psi	Grade Count = 1
Izod Impact, Notched	0.39 - 1.9 J/cm	0.731 - 3.56 ft-lb/in	Average = 0.81 J/cm; Grade Count = 11
Izod Impact, Notched Low Temp	0.34 - 0.49 J/cm	0.637 - 0.918 ft-lb/in	Average = 0.41 J/cm; Grade Count = 6
Charpy Impact, Unnotched	2 - 22 J/cm²	9.52 - 105 ft-lb/in²	Average = 9 J/cm²; Grade Count = 8
Charpy Impact, Notched Low Temp	0.3 - 0.7 J/cm²	1.43 - 3.33 ft-lb/in²	Average = 0.49 J/cm²; Grade Count = 4
Charpy Impact, Unnotched Low Temp	1 - 14.5 J/cm²	4.76 - 69 ft-lb/in²	Average = 4.6 J/cm²; Grade Count = 4
Charpy Impact, Notched	0.4 - 2.4 J/cm²	1.9 - 11.4 ft-lb/in²	Average = 0.95 J/cm²; Grade Count = 8
Coefficient of Friction	0.15	0.15	Grade Count=1
Coefficient of Friction, Static	0.23	0.23	Grade Count=1
Tensile Creep Modulus, 1 hour	1500 - 2000 MPa	218000 - 290000 psi	Average = 1800 MPa; Grade Count = 2
Tensile Creep Modulus, 1000 hours	800 - 1250 MPa	116000 - 181000 psi	Average = 1000 MPa; Grade Count = 3
Taber Abrasion, mg/1000 Cycles	20	20	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+011 - 1e+015 ohm-cm	1e+011 - 1e+015 ohm-cm	Average = 5E+14 ohm-cm; Grade Count = 16
Surface Resistance	1e+010 - 1e+015 ohm	1e+010 - 1e+015 ohm	Average = 1E+14 ohm; Grade Count = 14
Dielectric Constant	3.5 - 6.2	3.5 - 6.2	Average = 4.3; Grade Count = 13
Dielectric Constant, Low Frequency	4 - 15	4 - 15	Average = 8.1; Grade Count = 7
Dielectric Strength	21 - 95 kV/mm	533 - 2410 kV/in	Average = 42.9 kV/mm; Grade Count = 9
Dissipation Factor	0.01 - 0.33	0.01 - 0.33	Average = 0.1; Grade Count = 13
Dissipation Factor, Low Frequency	0.01 - 2.4	0.01 - 2.4	Average = 0.41; Grade Count = 7
Arc Resistance	60 - 120 sec	60 - 120 sec	Average = 72 sec; Grade Count=5
Comparative Tracking Index	375 - 600 V	375 - 600 V	Average = 520 V; Grade Count=9
Hot Wire Ignition, HWI	30 sec	30 sec	Grade Count = 4

High Amp Arc Ignition, HAI	120 arcs	120 arcs	Grade Count = 4
Thermal Properties			
CTE, linear 20°C	40 - 65 µm/m-°C	22.2 - 36.1 µin/in-°F	Average = 53.7 µm/m-°C; Grade Count=6
CTE, linear 20°C Transverse to Flow	40 - 60 µm/m-°C	22.2 - 33.3 µin/in-°F	Average = 55 µm/m-°C; Grade Count=4
Melting Point	215 - 222 °C	419 - 432 °F	Average = 220°C; Grade Count = 16
Maximum Service Temperature, Air	65 - 200 °C	149 - 392 °F	Average = 130°C; Grade Count = 15
Deflection Temperature at 0.46 MPa (66 psi)	177 - 200 °C	351 - 392 °F	Average = 190°C; Grade Count=13
Deflection Temperature at 1.8 MPa (264 psi)	65 - 160 °C	149 - 320 °F	Average = 110°C; Grade Count=17
Vicat Softening Point	200 - 205 °C	392 - 401 °F	Average = 200°C; Grade Count = 6
UL RTI, Electrical	65 °C	149 °F	Grade Count = 5
UL RTI, Mechanical with Impact	65 °C	149 °F	Grade Count = 5
UL RTI, Mechanical without Impact	65 °C	149 °F	Grade Count = 5
Flammability, UL94	HB - V-2	HB - V-2	Grade Count = 17, HB is typical
Oxygen Index	22 - 36 %	22 - 36 %	Average = 29%; Grade Count = 2
Processing Properties			
Processing Temperature	270 - 275 °C	518 - 527 °F	Average = 270°C; Grade Count = 8
Rear Barrel Temperature	260 °C	500 °F	Grade Count = 2
Middle Barrel Temperature	260 °C	500 °F	Grade Count = 2
Front Barrel Temperature	270 °C	518 °F	Grade Count = 2
Nozzle Temperature	270 °C	518 °F	Grade Count = 2
Mold Temperature	79 - 80 °C	174 - 176 °F	Average = 79.5°C; Grade Count = 4
Drying Temperature	82 - 85 °C	180 - 185 °F	Average = 83.5°C; Grade Count = 4

MatWeb, The Online Materials Database

Overview - Nylon 6, 40% Mineral Filled

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 6; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 6; PA6; PA 6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.46 - 1.58 g/cc	0.0527 - 0.0571 lb/in³	Average = 1.49 g/cc; Grade Count = 21
Water Absorption	0.7 - 6 %	0.7 - 6 %	Average = 1.8%; Grade Count = 16
Moisture Absorption at Equilibrium	1.6 - 2.1 %	1.6 - 2.1 %	Average = 1.9%; Grade Count = 8
Water Absorption at Saturation	5.7 - 6.4 %	5.7 - 6.4 %	Average = 6%; Grade Count = 7
Linear Mold Shrinkage	0.005 - 0.01 cm/cm	0.005 - 0.01 in/in	Average = 0.00917 cm/cm; Grade Count = 18
Linear Mold Shrinkage, Transverse	0.01 - 0.012 cm/cm	0.01 - 0.012 in/in	Average = 0.011 cm/cm; Grade Count = 11
Mechanical Properties			
Hardness, Rockwell M	90 - 95	90 - 95	Average = 92.5; Grade Count = 4
Hardness, Rockwell R	105 - 122	105 - 122	Average = 120; Grade Count = 7
Tensile Strength, Ultimate	50 - 86.2 MPa	7250 - 12500 psi	Average = 72.5 MPa; Grade Count = 12
Tensile Strength, Yield	49 - 90 MPa	7110 - 13100 psi	Average = 79.3 MPa; Grade Count = 10

Elongation at Break	2 - 45 %	2 - 45 %	Average = 13.1%; Grade Count = 21
Elongation at Yield	3 - 15 %	3 - 15 %	Average = 7.3%; Grade Count = 3
Tensile Modulus	2 - 7.6 GPa	290 - 1100 ksi	Average = 5 GPa; Grade Count = 12
Flexural Modulus	1.8 - 7.1 GPa	261 - 1030 ksi	Average = 4.8 GPa; Grade Count = 18
Flexural Yield Strength	54 - 155 MPa	7830 - 22500 psi	Average = 120 MPa; Grade Count = 17
Compressive Yield Strength	29 - 186 MPa	4210 - 27000 psi	Average = 110 MPa; Grade Count=5
Poisson's Ratio	0.35	0.35	Grade Count = 2
Shear Strength	69 - 71 MPa	10000 - 10300 psi	Average = 70 MPa; Grade Count = 2
Izod Impact, Notched	0.3 - 1.57 J/cm	0.562 - 2.94 ft-lb/in	Average = 0.65 J/cm; Grade Count = 17
Izod Impact, Unnotched	2.1 - 2.9 J/cm	3.93 - 5.43 ft-lb/in	Average = 2.5 J/cm; Grade Count = 2
Izod Impact, Notched Low Temp	0.34 - 0.49 J/cm	0.637 - 0.918 ft-lb/in	Average = 0.41 J/cm; Grade Count = 6
Charpy Impact, Notched Low Temp	0.27 J/cm²	1.28 ft-lb/in²	Grade Count = 1
Charpy Impact, Notched	0.35 J/cm²	1.67 ft-lb/in²	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+011 - 1e+016 ohm-cm	1e+011 - 1e+016 ohm-cm	Average = 1.7E+15 ohm-cm; Grade Count = 9
Surface Resistance	1e+012 - 1e+014 ohm	1e+012 - 1e+014 ohm	Average = 5E+13 ohm; Grade Count = 6
Dielectric Constant	3.8 - 4	3.8 - 4	Average = 3.9; Grade Count = 6
Dielectric Constant, Low Frequency	5 - 15	5 - 15	Average = 10; Grade Count = 4
Dielectric Strength	18.1 - 35 kV/mm	460 - 889 kV/in	Average = 28.5 kV/mm; Grade Count = 7
Dissipation Factor	0.015 - 0.07	0.015 - 0.07	Average = 0.034; Grade Count = 6
Arc Resistance	60 - 115 sec	60 - 115 sec	Average = 71 sec; Grade Count=5
Comparative Tracking Index	575 V	575 V	Grade Count=2
Hot Wire Ignition, HWI	30 sec	30 sec	Grade Count = 4
High Amp Arc Ignition, HAI	120 arcs	120 arcs	Grade Count = 4

Thermal Properties

CTE, linear 20°C	43 - 50 µm/m-°C	23.9 - 27.8 µin/in-°F	Average = 47.2 µm/m-°C; Grade Count=5
CTE, linear 20°C Transverse to Flow	58 µm/m-°C	32.2 µin/in-°F	Grade Count=1
Specific Heat Capacity	2 J/g-°C	0.478 BTU/lb-°F	Grade Count = 1
Thermal Conductivity	0.281 - 1.22 W/m-K	1.95 - 8.47 BTU-in/hr-ft²-°F	Average = 0.7 W/m-K; Grade Count = 3

Melting Point	215 - 222 °C	419 - 432 °F	Average = 220°C; Grade Count = 14
Maximum Service Temperature, Air	105 - 200 °C	221 - 392 °F	Average = 150°C; Grade Count = 14
Deflection Temperature at 0.46 MPa (66 psi)	182 - 210 °C	360 - 410 °F	Average = 200°C; Grade Count=11
Deflection Temperature at 1.8 MPa (264 psi)	105 - 185 °C	221 - 365 °F	Average = 130°C; Grade Count=18
Vicat Softening Point	200 °C	392 °F	Grade Count = 3
UL RTI, Electrical	65 °C	149 °F	Grade Count = 4
UL RTI, Mechanical with Impact	65 °C	149 °F	Grade Count = 4
UL RTI, Mechanical without Impact	65 °C	149 °F	Grade Count = 4
Flammability, UL94	HB - V-0	HB - V-0	Grade Count = 12, HB is typical

Processing Properties

Processing Temperature	270 - 275 °C	518 - 527 °F	Average = 270°C; Grade Count = 10
Mold Temperature	79 - 95 °C	174 - 203 °F	Average = 89.7°C; Grade Count = 6
Drying Temperature	85 °C	185 °F	Grade Count = 2

MatWeb, The Online Materials Database

Overview - Nylon 6, Impact Grade

Subcategory: Nylon; Nylon 6; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 6; PA6; PA 6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.06 - 1.11 g/cc	0.0383 - 0.0401 lb/in³	Average = 1.09 g/cc; Grade Count = 70
Water Absorption	0.3 - 9 %	0.3 - 9 %	Average = 3.5%; Grade Count = 46
Moisture Absorption at Equilibrium	1.9 - 3 %	1.9 - 3 %	Average = 2.4%; Grade Count = 32
Water Absorption at Saturation	6.7 - 9 %	6.7 - 9 %	Average = 7.9%; Grade Count = 25
Linear Mold Shrinkage	0.007 - 0.016 cm/cm	0.007 - 0.016 in/in	Average = 0.013 cm/cm; Grade Count = 51
Linear Mold Shrinkage, Transverse	0.009 - 0.019 cm/cm	0.009 - 0.019 in/in	Average = 0.016 cm/cm; Grade Count = 30
Melt Flow	25 - 170 g/10 min	25 - 170 g/10 min	Average = 80 g/10 min; Grade Count = 7
Mechanical Properties			
Hardness, Rockwell M	62 - 75	62 - 75	Average = 72.4; Grade Count = 5
Hardness, Rockwell R	88 - 115	88 - 115	Average = 110; Grade Count = 16
Hardness, Shore D	79	79	Grade Count = 1

Tensile Strength, Ultimate	40 - 70 MPa	5800 - 10200 psi	Average = 53.5 MPa; Grade Count = 33
Tensile Strength, Yield	24 - 72 MPa	3480 - 10400 psi	Average = 50.8 MPa; Grade Count = 49
Elongation at Break	15 - 310 %	15 - 310 %	Average = 130%; Grade Count = 62
Elongation at Yield	3.5 - 30 %	3.5 - 30 %	Average = 11.8%; Grade Count = 30
Tensile Modulus	0.6 - 2.8 GPa	87 - 406 ksi	Average = 1.7 GPa; Grade Count = 31
Flexural Modulus	0.39 - 2.39 GPa	56.6 - 347 ksi	Average = 1.6 GPa; Grade Count = 50
Flexural Yield Strength	14 - 95 MPa	2030 - 13800 psi	Average = 60.8 MPa; Grade Count = 47
Compressive Yield Strength	10 - 55 MPa	1450 - 7980 psi	Average = 42 MPa; Grade Count=5
Poisson's Ratio	0.35	0.35	Grade Count = 10
Shear Strength	24 - 35 MPa	3480 - 5080 psi	Average = 29.5 MPa; Grade Count = 2
Izod Impact, Notched	0.7 - NB	1.31 - NB	Average = 6.8 J/cm (NB computed as 15 J/cm); Grade Count = 42
Izod Impact, Unnotched	18.7 - NB	35 - NB	Average = 19.4 J/cm (NB computed as 20 J/cm); Grade Count = 2
Izod Impact, Notched Low Temp	0.8 - 2 J/cm	1.5 - 3.75 ft-lb/in	Average = 1.3 J/cm; Grade Count = 15
Charpy Impact, Unnotched	NB	NB	Grade Count = 14
Charpy Impact, Notched Low Temp	0.6 - 1.5 J/cm²	2.86 - 7.14 ft-lb/in²	Average = 0.95 J/cm²; Grade Count = 8
Charpy Impact, Unnotched Low Temp	1 - NB	4.76 - NB	Average = 11.5 J/cm² (NB computed as 20 J/cm²); Grade Count = 13
Charpy Impact, Notched	0.7 - 12 J/cm²	3.33 - 57.1 ft-lb/in²	Average = 5.5 J/cm²; Grade Count = 17
Coefficient of Friction	0.16	0.16	Grade Count=1
Coefficient of Friction, Static	0.25	0.25	Grade Count=1
Tensile Creep Modulus, 1 hour	650 - 900 MPa	94300 - 131000 psi	Average = 780 MPa; Grade Count = 3
Tensile Creep Modulus, 1000 hours	450 - 550 MPa	65300 - 79800 psi	Average = 520 MPa; Grade Count = 3
Taber Abrasion, mg/1000 Cycles	18	18	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+012 - 1e+015 ohm-cm	1e+012 - 1e+015 ohm-cm	Average = 4E+140 ohm-cm; Grade Count = 31
Surface Resistance	1e+010 - 1e+015 ohm	1e+010 - 1e+015 ohm	Average = 2E+14 ohm ohm; Grade Count = 26
Dielectric Constant	2 - 6.4	2 - 6.4	Average = 3.8; Grade Count = 24
Dielectric Constant, Low Frequency	2 - 14	2 - 14	Average = 6.3; Grade Count = 21
Dielectric Strength	20 - 100 kV/mm	508 - 2540 kV/in	Average = 36.2 kV/mm; Grade Count = 25

Dissipation Factor	0.0075 - 1.2	0.0075 - 1.2	Average = 0.26; Grade Count = 22
Dissipation Factor, Low Frequency	0.003 - 2.65	0.003 - 2.65	Average = 0.7; Grade Count = 21
Arc Resistance	60 - 125 sec	60 - 125 sec	Average = 79.7 sec; Grade Count=6
Comparative Tracking Index	550 - 600 V	550 - 600 V	Average = 600 V; Grade Count=20
Hot Wire Ignition, HWI	7 sec	7 sec	Grade Count = 4
High Amp Arc Ignition, HAI	120 arcs	120 arcs	Grade Count = 4

Thermal Properties

CTE, linear 20°C	20 - 140 µm/m-°C	11.1 - 77.8 µin/in-°F	Average = 95.5 µm/m-°C; Grade Count=19
CTE, linear 20°C Transverse to Flow	93 - 150 µm/m-°C	51.7 - 83.3 µin/in-°F	Average = 120 µm/m-°C; Grade Count=12
Specific Heat Capacity	3.9 J/g-°C	0.932 BTU/lb-°F	Grade Count = 2
Thermal Conductivity	0.17 W/m-K	1.18 BTU-in/hr-ft²-°F	Grade Count = 2
Melting Point	210 - 222 °C	410 - 432 °F	Average = 220°C; Grade Count = 52
Maximum Service Temperature, Air	42 - 185 °C	108 - 365 °F	Average = 96.4°C; Grade Count = 43
Deflection Temperature at 0.46 MPa (66 psi)	70 - 185 °C	158 - 365 °F	Average = 150°C; Grade Count=40
Deflection Temperature at 1.8 MPa (264 psi)	42 - 105 °C	108 - 221 °F	Average = 59.3°C; Grade Count=57
Vicat Softening Point	140 - 204 °C	284 - 399 °F	Average = 170°C; Grade Count = 14
UL RTI, Electrical	65 °C	149 °F	Grade Count = 12
UL RTI, Mechanical with Impact	65 °C	149 °F	Grade Count = 12
UL RTI, Mechanical without Impact	65 °C	149 °F	Grade Count = 12
Flammability, UL94	HB	HB	Grade Count = 41
Oxygen Index	21 - 22 %	21 - 22 %	Average = 21.3%; Grade Count = 3

Processing Properties

Processing Temperature	238 - 280 °C	460 - 536 °F	Average = 270°C; Grade Count = 32
Rear Barrel Temperature	230 °C	446 °F	Grade Count = 4
Middle Barrel Temperature	240 °C	464 °F	Grade Count = 4
Front Barrel Temperature	240 °C	464 °F	Grade Count = 4
Nozzle Temperature	240 °C	464 °F	Grade Count = 4
Mold Temperature	52 - 95 °C	126 - 203 °F	Average = 71.4°C; Grade Count = 16
Drying Temperature	82 - 85 °C	180 - 185 °F	Average = 84.5°C; Grade Count = 24

Overview - Nylon 6, Mineral Reinforced, Impact Grade

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Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 6; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 6; PA6; PA 6; Plastics, Polymers

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The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments

Density	1.18 - 1.43 g/cc	0.0426 - 0.0517 lb/in³	Average = 1.38 g/cc; Grade Count = 12
Water Absorption	2.2 - 3.1 %	2.2 - 3.1 %	Average = 2.7%; Grade Count = 2
Moisture Absorption at Equilibrium	1.2 - 2.2 %	1.2 - 2.2 %	Average = 1.6%; Grade Count = 5
Water Absorption at Saturation	2.2 - 5.8 %	2.2 - 5.8 %	Average = 4.7%; Grade Count = 4
Linear Mold Shrinkage	0.009 - 0.012 cm/cm	0.009 - 0.012 in/in	Average = 0.011 cm/cm; Grade Count = 12
Linear Mold Shrinkage, Transverse	0.01 - 0.012 cm/cm	0.01 - 0.012 in/in	Average = 0.011 cm/cm; Grade Count = 6
Melt Flow	12 g/10 min	12 g/10 min	Grade Count = 1

Mechanical Properties

Hardness, Rockwell R	103 - 116	103 - 116	Average = 110; Grade Count = 2
Tensile Strength, Ultimate	36 - 75 MPa	5220 - 10900 psi	Average = 56.6 MPa; Grade Count = 7
Tensile Strength, Yield	45 - 75 MPa	6530 - 10900 psi	Average = 65 MPa; Grade Count = 4
Elongation at Break	15 - 55 %	15 - 55 %	Average = 27.4%; Grade Count = 10
Elongation at Yield	3 - 30 %	3 - 30 %	Average = 16.5%; Grade Count = 2
Tensile Modulus	1.6 - 4.9 GPa	232 - 711 ksi	Average = 3.2 GPa; Grade Count = 7
Flexural Modulus	1.4 - 4.485 GPa	203 - 651 ksi	Average = 3.2 GPa; Grade Count = 10
Flexural Yield Strength	50 - 130 MPa	7250 - 18900 psi	Average = 93.3 MPa; Grade Count = 10
Poisson's Ratio	0.35	0.35	Grade Count = 3
Izod Impact, Notched	1.07 - 2.3 J/cm	2 - 4.31 ft-lb/in	Average = 1.6 J/cm; Grade Count = 6
Izod Impact, Unnotched	NB	NB	Grade Count = 2
Izod Impact, Notched Low Temp	0.4 J/cm	0.749 ft-lb/in	Grade Count = 4
Charpy Impact, Notched Low Temp	0.32 - 0.5 J/cm²	1.52 - 2.38 ft-lb/in²	Average = 0.4 J/cm²; Grade Count = 3
Charpy Impact, Notched	0.6 - 0.7 J/cm²	2.86 - 3.33 ft-lb/in²	Average = 0.67 J/cm²; Grade Count = 3

Electrical Properties

Electrical Resistivity	1e+012 - 1e+015 ohm-cm	1e+012 - 1e+015 ohm-cm	Average = 4E+14 ohm-cm; Grade Count = 6
Surface Resistance	1e+014 ohm	1e+014 ohm	Grade Count = 4
Dielectric Constant	4 - 4.5	4 - 4.5	Average = 4.2; Grade Count = 4
Dielectric Constant, Low Frequency	5 - 15	5 - 15	Average = 10; Grade Count = 4
Dielectric Strength	35 kV/mm	889 kV/in	Grade Count = 4
Dissipation Factor	0.025 - 0.075	0.025 - 0.075	Average = 0.05; Grade Count = 4

Comparative Tracking Index	600 V	600 V	Grade Count=3

Thermal Properties

CTE, linear 20°C	23 - 68 µm/m-°C	12.8 - 37.8 µin/in-°F	Average = 45.5 µm/m-°C; Grade Count=2
CTE, linear 20°C Transverse to Flow	76 µm/m-°C	42.2 µin/in-°F	Grade Count=1
Specific Heat Capacity	2.8 J/g-°C	0.669 BTU/lb-°F	Grade Count = 1
Thermal Conductivity	0.23 W/m-K	1.6 BTU-in/hr-ft²-°F	Grade Count = 1
Melting Point	215 - 222 °C	419 - 432 °F	Average = 220°C; Grade Count = 10
Maximum Service Temperature, Air	75 - 190 °C	167 - 374 °F	Average = 130°C; Grade Count = 7
Deflection Temperature at 0.46 MPa (66 psi)	166 - 191 °C	331 - 376 °F	Average = 180°C; Grade Count=7
Deflection Temperature at 1.8 MPa (264 psi)	58 - 90 °C	136 - 194 °F	Average = 82.3°C; Grade Count=10
Vicat Softening Point	200 °C	392 °F	Grade Count = 1
UL RTI, Electrical	65 °C	149 °F	Grade Count = 4
UL RTI, Mechanical with Impact	65 °C	149 °F	Grade Count = 4
UL RTI, Mechanical without Impact	65 °C	149 °F	Grade Count = 4
Flammability, UL94	HB	HB	Grade Count = 6

Processing Properties

Processing Temperature	265 - 275 °C	509 - 527 °F	Average = 270°C; Grade Count = 6
Mold Temperature	95 °C	203 °F	Grade Count = 4
Drying Temperature	85 °C	185 °F	Grade Count = 6

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Overview - Nylon 66, Unreinforced

Subcategory: Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
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Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.03 - 1.16 g/cc	0.0372 - 0.0419 lb/in³	Average = 1.12 g/cc; Grade Count = 54
Apparent Bulk Density	0.7 g/cc	0.0253 lb/in³	Grade Count=1
Water Absorption	0.97 - 8.5 %	0.97 - 8.5 %	Average = 2.3%; Grade Count = 31
Moisture Absorption at Equilibrium	1.1 - 2.5 %	1.1 - 2.5 %	Average = 2%; Grade Count = 11
Water Absorption at Saturation	1.2 - 9 %	1.2 - 9 %	Average = 7.6%; Grade Count = 7
Linear Mold Shrinkage	0.006 - 0.019 cm/cm	0.006 - 0.019 in/in	Average = 0.015 cm/cm; Grade Count = 27
Linear Mold Shrinkage, Transverse	0.019 - 0.022 cm/cm	0.019 - 0.022 in/in	Average = 0.021 cm/cm; Grade Count = 3
Melt Flow	15 - 75 g/10 min	15 - 75 g/10 min	Average = 26 g/10 min; Grade Count = 6

Mechanical Properties

Hardness, Rockwell M	60 - 87	60 - 87	Average = 71.6; Grade Count = 8
Hardness, Rockwell R	93 - 122	93 - 122	Average = 110; Grade Count = 20
Tensile Strength, Ultimate	40 - 85.5 MPa	5800 - 12400 psi	Average = 73.1 MPa; Grade Count = 28
Tensile Strength, Yield	40 - 86 MPa	5800 - 12500 psi	Average = 63.6 MPa; Grade Count = 32
Elongation at Break	4.8 - 300 %	4.8 - 300 %	Average = 82.8%; Grade Count = 50
Elongation at Yield	3.4 - 30 %	3.4 - 30 %	Average = 10.7%; Grade Count = 20
Tensile Modulus	0.7 - 3.3 GPa	102 - 479 ksi	Average = 2.1 GPa; Grade Count = 21
Flexural Modulus	0.9 - 3.4 GPa	131 - 493 ksi	Average = 2.4 GPa; Grade Count = 37
Flexural Yield Strength	34 - 124.1 MPa	4930 - 18000 psi	Average = 88.4 MPa; Grade Count = 25
Compressive Yield Strength	11 - 100 MPa	1600 - 14500 psi	Average = 32.5 MPa; Grade Count=6
Shear Strength	50 - 66.2 MPa	7250 - 9600 psi	Average = 61.7 MPa; Grade Count = 7
Izod Impact, Notched	0.4 - 13 J/cm	0.749 - 24.4 ft-lb/in	Average = 1.5 J/cm; Grade Count = 40
Izod Impact, Unnotched	8 - 10.7 J/cm	15 - 20 ft-lb/in	Average = 9.4 J/cm; Grade Count = 2
Izod Impact, Notched Low Temp	0.27 - 0.35 J/cm	0.506 - 0.656 ft-lb/in	Average = 0.31 J/cm; Grade Count = 3
Charpy Impact, Unnotched	4 - NB	19 - NB	Average = 18.2 J/cm² (NB computed as 20 J/cm²); Grade Count = 9
Charpy Impact, Notched Low Temp	2 J/cm²	9.52 ft-lb/in²	Grade Count = 2
Charpy Impact, Unnotched Low Temp	NB	NB	Grade Count = 2
Charpy Impact, Notched	0.5 - 12 J/cm²	2.38 - 57.1 ft-lb/in²	Average = 3.4 J/cm²; Grade Count = 9
Tensile Impact Strength	540 kJ/m²	257 ft-lb/in²	Grade Count = 1
Coefficient of Friction	0.09	0.09	Grade Count=1
Tensile Creep Modulus, 1 hour	1100 - 2270 MPa	160000 - 329000 psi	Average = 1500 MPa; Grade Count = 5
Tensile Creep Modulus, 1000 hours	7.5 - 980 MPa	1090 - 142000 psi	Average = 570 MPa; Grade Count = 7
K (wear) Factor	180	180	Grade Count = 1
Limiting Pressure Velocity	0.021 MPa-m/sec	600 psi-ft/min	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+012 - 5.46e+016 ohm-cm	1e+012 - 5.46e+016 ohm-cm	Average = 2.4E+15 ohm-cm; Grade Count = 27
Surface Resistance	1e+010 - 1e+015 ohm	1e+010 - 1e+015 ohm	Average = 3E+14 ohm; Grade Count = 15
Dielectric Constant	3 - 5	3 - 5	Average = 3.9; Grade Count = 26

Dielectric Constant, Low Frequency	1.9 - 7.4	1.9 - 7.4	Average = 4.5; Grade Count = 16
Dielectric Strength	17 - 120 kV/mm	432 - 3050 kV/in	Average = 45.7 kV/mm; Grade Count = 20
Dissipation Factor	0.015 - 0.2	0.015 - 0.2	Average = 0.079; Grade Count = 19
Dissipation Factor, Low Frequency	0.0035 - 0.2	0.0035 - 0.2	Average = 0.056; Grade Count = 13
Comparative Tracking Index	600 V	600 V	Grade Count=10
Thermal Properties			
CTE, linear 20°C	65 - 150 µm/m-°C	36.1 - 83.3 µin/in-°F	Average = 100 µm/m-°C; Grade Count=12
CTE, linear 20°C Transverse to Flow	110 - 150 µm/m-°C	61.1 - 83.3 µin/in-°F	Average = 140 µm/m-°C; Grade Count=4
CTE, linear 100°C	100 µm/m-°C	55.6 µin/in-°F	Grade Count=2
Specific Heat Capacity	1.6 - 2.75 J/g-°C	0.382 - 0.657 BTU/lb-°F	Average = 2.2 J/g-K; Grade Count = 2
Thermal Conductivity	0.25 - 0.28 W/m-K	1.74 - 1.94 BTU-in/hr-ft²-°F	Average = 0.26 W/m-K; Grade Count = 5
Melting Point	211 - 265 °C	412 - 509 °F	Average = 250°C; Grade Count = 41
Maximum Service Temperature, Air	60 - 235 °C	140 - 455 °F	Average = 100°C; Grade Count = 37
Deflection Temperature at 0.46 MPa (66 psi)	85 - 245 °C	185 - 473 °F	Average = 210°C; Grade Count=30
Deflection Temperature at 1.8 MPa (264 psi)	50 - 164 °C	122 - 327 °F	Average = 80.5°C; Grade Count=38
Vicat Softening Point	148 - 250 °C	298 - 482 °F	Average = 190°C; Grade Count = 5
Minimum Service Temperature, Air	-30 °C	-22 °F	Grade Count = 2
Brittleness Temperature	-100 - -79 °C	-148 - -110 °F	Average = -88°C; Grade Count=3
UL RTI, Electrical	65 °C	149 °F	Grade Count = 2
UL RTI, Mechanical with Impact	65 °C	149 °F	Grade Count = 2
UL RTI, Mechanical without Impact	65 °C	149 °F	Grade Count = 2
Flammability, UL94	HB	HB	Grade Count = 24
Oxygen Index	22 - 24 %	22 - 24 %	Average = 23.3%; Grade Count = 3
Processing Properties			
Processing Temperature	279 - 300 °C	534 - 572 °F	Average = 290°C; Grade Count = 6
Rear Barrel Temperature	272 - 293 °C	522 - 559 °F	Average = 290°C; Grade Count = 3
Middle Barrel Temperature	282 - 293 °C	540 - 559 °F	Average = 290°C; Grade Count = 3
Front Barrel Temperature	285 - 287 °C	545 - 549 °F	Average = 290°C; Grade Count = 3

Nozzle Temperature	280 °C	536 °F	Grade Count = 2
Mold Temperature	66 - 106 °C	151 - 223 °F	Average = 79.8°C; Grade Count = 4
Drying Temperature	82 - 106 °C	180 - 223 °F	Average = 90°C; Grade Count = 3

MatWeb, The Online Materials Database

Overview - Nylon 66, 10% Mineral Filled

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.2 - 1.45 g/cc	0.0434 - 0.0524 lb/in³	Average = 1.29 g/cc; Grade Count = 3
Water Absorption	0.8 %	0.8 %	Grade Count = 2
Linear Mold Shrinkage	0.015 - 0.02 cm/cm	0.015 - 0.02 in/in	Average = 0.018 cm/cm; Grade Count = 2
Mechanical Properties			
Hardness, Rockwell R	110	110	Grade Count = 1
Tensile Strength, Ultimate	48 - 90 MPa	6960 - 13100 psi	Average = 69 MPa; Grade Count = 2
Tensile Strength, Yield	90 MPa	13100 psi	Grade Count = 1
Elongation at Break	2 - 10 %	2 - 10 %	Average = 6%; Grade Count = 2
Tensile Modulus	3.4 - 5 GPa	493 - 725 ksi	Average = 4.2 GPa; Grade Count = 2
Flexural Modulus	3.4 - 5 GPa	493 - 725 ksi	Average = 4.2 GPa; Grade Count = 2
Flexural Yield Strength	97 - 100 MPa	14100 - 14500 psi	Average = 98.5 MPa; Grade Count = 2

Compressive Yield Strength	105 MPa	15200 psi	Grade Count=1
Izod Impact, Notched	0.29 - 1.5 J/cm	0.543 - 2.81 ft-lb/in	Average = 0.89 J/cm; Grade Count = 2
Electrical Properties			
Electrical Resistivity	1e+014 ohm-cm	1e+014 ohm-cm	Grade Count = 1
Dielectric Strength	15 kV/mm	381 kV/in	Grade Count = 1
Dissipation Factor	0.015	0.015	Grade Count = 1
Dissipation Factor, Low Frequency	0.015	0.015	Grade Count = 1
Thermal Properties			
CTE, linear 20°C	45 µm/m-°C	25 µin/in-°F	Grade Count=1
Specific Heat Capacity	1.2 J/g-°C	0.287 BTU/lb-°F	Grade Count = 1
Thermal Conductivity	0.4 W/m-K	2.78 BTU-in/hr-ft²-°F	Grade Count = 1
Melting Point	270 °C	518 °F	Grade Count = 1
Maximum Service Temperature, Air	160 °C	320 °F	Grade Count = 1
Deflection Temperature at 0.46 MPa (66 psi)	200 - 232 °C	392 - 450 °F	Average = 220°C; Grade Count=2
Deflection Temperature at 1.8 MPa (264 psi)	160 - 218 °C	320 - 424 °F	Average = 190°C; Grade Count=2
Processing Properties			
Processing Temperature	279 - 280 °C	534 - 536 °F	Average = 280°C; Grade Count = 2
Mold Temperature	100 °C	212 °F	Grade Count = 1
Drying Temperature	100 °C	212 °F	Grade Count = 1

Overview - Nylon 66, 20% Mineral Filled

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Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

Click here to view available vendors for this material.

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments

Density	1.28 - 1.73 g/cc	0.0462 - 0.0625 lb/in³	Average = 1.37 g/cc; Grade Count = 8
Water Absorption	0.5 - 0.8 %	0.5 - 0.8 %	Average = 0.63%; Grade Count = 3
Water Absorption at Saturation	5.9 %	5.9 %	Grade Count = 1
Linear Mold Shrinkage	0.0033 - 0.0185 cm/cm	0.0033 - 0.0185 in/in	Average = 0.01 cm/cm; Grade Count = 6
Linear Mold Shrinkage, Transverse	0.013 cm/cm	0.013 in/in	Grade Count = 1
Melt Flow	25 g/10 min	25 g/10 min	Grade Count = 1

Mechanical Properties

Hardness, Rockwell R	120	120	Grade Count = 1
Tensile Strength, Ultimate	55 - 131 MPa	7980 - 19000 psi	Average = 85 MPa; Grade Count = 7
Elongation at Break	2 - 50 %	2 - 50 %	Average = 13.9%; Grade Count = 7
Tensile Modulus	2 - 9.3 GPa	290 - 1350 ksi	Average = 5.2 GPa; Grade Count = 7
Flexural Modulus	4.1 - 9.3 GPa	595 - 1350 ksi	Average = 6.1 GPa; Grade Count = 5
Flexural Yield Strength	110 - 241 MPa	16000 - 35000 psi	Average = 160 MPa; Grade Count = 5
Compressive Yield Strength	61 MPa	8850 psi	Grade Count=1
Izod Impact, Notched	0.32 - 0.67 J/cm	0.599 - 1.26 ft-lb/in	Average = 0.46 J/cm; Grade Count = 5
Izod Impact, Unnotched	2.7 J/cm	5.06 ft-lb/in	Grade Count = 1
Charpy Impact, Unnotched	Min 28 J/cm²	Min 133 ft-lb/in²	Grade Count = 2
Charpy Impact, Notched Low Temp	0.8 J/cm²	3.81 ft-lb/in²	Grade Count = 1
Charpy Impact, Unnotched Low Temp	7 J/cm²	33.3 ft-lb/in²	Grade Count = 1
Charpy Impact, Notched	1.4 - 2.3 J/cm²	6.66 - 10.9 ft-lb/in²	Average = 1.8 J/cm²; Grade Count = 2
Tensile Creep Modulus, 1000 hours	1200 MPa	174000 psi	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+012 - 1e+015 ohm-cm	1e+012 - 1e+015 ohm-cm	Average = 4E+14 ohm-cm; Grade Count = 5
Surface Resistance	1e+010 - 1e+012 ohm	1e+010 - 1e+012 ohm	Average = 5E+11 ohm; Grade Count = 2
Dielectric Constant	3.7 - 4	3.7 - 4	Average = 3.9; Grade Count = 3
Dielectric Strength	18.5 kV/mm	470 kV/in	Grade Count = 1
Dissipation Factor	0.014 - 0.05	0.014 - 0.05	Average = 0.027; Grade Count = 3
Arc Resistance	110 sec	110 sec	Grade Count=1
Comparative Tracking Index	600 V	600 V	Grade Count=1

Thermal Properties

CTE, linear 20°C	68 - 100 µm/m-°C	37.8 - 55.6 µin/in-°F	Average = 84 µm/m-°C; Grade Count=2
Thermal Conductivity	0.27 W/m-K	1.87 BTU-in/hr-ft²-°F	Grade Count = 1
Melting Point	260 °C	500 °F	Grade Count = 1
Maximum Service Temperature, Air	70 - 163 °C	158 - 325 °F	Average = 120°C; Grade Count = 2
Deflection Temperature at 0.46 MPa (66 psi)	216 - 238 °C	421 - 460 °F	Average = 230°C; Grade Count=3
Deflection Temperature at 1.8 MPa (264 psi)	70 - 257 °C	158 - 495 °F	Average = 180°C; Grade Count=4
Flammability, UL94	HB	HB	Grade Count = 2

Processing Properties

Processing Temperature	282 - 332 °C	540 - 630 °F	Average = 300°C; Grade Count = 4
Mold Temperature	66 - 100 °C	151 - 212 °F	Average = 88.5°C; Grade Count = 4
Drying Temperature	77 - 100 °C	171 - 212 °F	Average = 92°C; Grade Count = 4

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MatWeb, The Online Materials Database

Overview - Nylon 66, 30% Mineral Filled

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.23 - 1.382 g/cc	0.0444 - 0.0499 lb/in³	Average = 1.34 g/cc; Grade Count = 13
Water Absorption	0.4 - 5.5 %	0.4 - 5.5 %	Average = 2.1%; Grade Count = 6
Moisture Absorption at Equilibrium	1.05 - 2.1 %	1.05 - 2.1 %	Average = 1.8%; Grade Count = 4
Water Absorption at Saturation	2 - 5.5 %	2 - 5.5 %	Average = 3.2%; Grade Count = 3
Linear Mold Shrinkage	0.014 - 0.0175 cm/cm	0.014 - 0.0175 in/in	Average = 0.016 cm/cm; Grade Count = 2
Melt Flow	9.5 g/10 min	9.5 g/10 min	Grade Count = 1
Mechanical Properties			
Tensile Strength, Ultimate	45 - 200 MPa	6530 - 29000 psi	Average = 95.6 MPa; Grade Count = 12
Tensile Strength, Yield	150 MPa	21800 psi	Grade Count = 1
Elongation at Break	2 - 45 %	2 - 45 %	Average = 13.1%; Grade Count = 13
Tensile Modulus	1.4 - 5.5 GPa	203 - 798 ksi	Average = 3.7 GPa; Grade Count = 8

Flexural Modulus	3.85 - 8.96 GPa	558 - 1300 ksi	Average = 7.1 GPa; Grade Count = 6
Flexural Yield Strength	115 - 152 MPa	16700 - 22000 psi	Average = 130 MPa; Grade Count = 2
Izod Impact, Notched	0.38 - 2.19 J/cm	0.712 - 4.1 ft-lb/in	Average = 1 J/cm; Grade Count = 6
Charpy Impact, Notched Low Temp	0.4 J/cm²	1.9 ft-lb/in²	Grade Count = 1
Charpy Impact, Notched	0.6 J/cm²	2.86 ft-lb/in²	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+011 - 1e+015 ohm-cm	1e+011 - 1e+015 ohm-cm	Average = 5E+14 ohm-cm; Grade Count = 4
Surface Resistance	1e+012 - 1e+015 ohm	1e+012 - 1e+015 ohm	Average = 3E+14 ohm; Grade Count = 4
Dielectric Constant	4 - 5	4 - 5	Average = 4.2; Grade Count = 4
Dielectric Constant, Low Frequency	4 - 25	4 - 25	Average = 10; Grade Count = 4
Dielectric Strength	35 kV/mm	889 kV/in	Grade Count = 4
Dissipation Factor	0.02 - 0.12	0.02 - 0.12	Average = 0.07; Grade Count = 2
Dissipation Factor, Low Frequency	0.01 - 0.5	0.01 - 0.5	Average = 0.19; Grade Count = 3
Comparative Tracking Index	400 - 600 V	400 - 600 V	Average = 500 V; Grade Count=2

Thermal Properties

Melting Point	253 - 263 °C	487 - 505 °F	Average = 260°C; Grade Count = 6
Maximum Service Temperature, Air	70 - 250 °C	158 - 482 °F	Average = 170°C; Grade Count = 6
Deflection Temperature at 0.46 MPa (66 psi)	210 - 243 °C	410 - 469 °F	Average = 230°C; Grade Count=4
Deflection Temperature at 1.8 MPa (264 psi)	70 - 250 °C	158 - 482 °F	Average = 170°C; Grade Count=8
Vicat Softening Point	200 - 230 °C	392 - 446 °F	Average = 220°C; Grade Count = 2
Flammability, UL94	HB	HB	Grade Count = 6

Processing Properties

Processing Temperature	290 °C	554 °F	Grade Count = 1
Mold Temperature	100 °C	212 °F	Grade Count = 1
Drying Temperature	100 °C	212 °F	Grade Count = 1

MatWeb, The Online Materials Database

Overview - Nylon 66, 40% Mineral Filled

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.41 - 1.7 g/cc	0.0509 - 0.0614 lb/in³	Average = 1.48 g/cc; Grade Count = 26
Water Absorption	0.06 - 5.1 %	0.06 - 5.1 %	Average = 1.5%; Grade Count = 15
Moisture Absorption at Equilibrium	1.5 %	1.5 %	Grade Count = 2
Water Absorption at Saturation	1.5 %	1.5 %	Grade Count = 1
Linear Mold Shrinkage	0.005 - 0.015 cm/cm	0.005 - 0.015 in/in	Average = 0.00975 cm/cm; Grade Count = 16
Linear Mold Shrinkage, Transverse	0.012 cm/cm	0.012 in/in	Grade Count = 1
Melt Flow	40 g/10 min	40 g/10 min	Grade Count = 1
Mechanical Properties			
Hardness, Rockwell M	95	95	Grade Count = 2
Hardness, Rockwell R	118 - 122	118 - 122	Average = 120; Grade Count = 10
Tensile Strength, Ultimate	45 - 193.1 MPa	6530 - 28000 psi	Average = 96.8 MPa; Grade Count = 16

Tensile Strength, Yield	69 - 120.7 MPa	10000 - 17500 psi	Average = 94 MPa; Grade Count = 8
Elongation at Break	1 - 75 %	1 - 75 %	Average = 8.3%; Grade Count = 26
Tensile Modulus	3.7 - 9.1 GPa	537 - 1320 ksi	Average = 6.3 GPa; Grade Count = 11
Flexural Modulus	4.1 - 10.34 GPa	595 - 1500 ksi	Average = 6.7 GPa; Grade Count = 20
Flexural Yield Strength	103 - 193 MPa	14900 - 28000 psi	Average = 150 MPa; Grade Count = 15
Compressive Yield Strength	69 - 252 MPa	10000 - 36500 psi	Average = 170 MPa; Grade Count=4
Izod Impact, Notched	0.2 - 1.3 J/cm	0.375 - 2.44 ft-lb/in	Average = 0.6 J/cm; Grade Count = 22
Izod Impact, Unnotched	1.6 - 2.7 J/cm	3 - 5.06 ft-lb/in	Average = 2.2 J/cm; Grade Count = 2
Charpy Impact, Unnotched	11.5 - NB	54.7 - NB	Average = 15.8 J/cm² (NB computed as 20 J/cm²); Grade Count = 2
Charpy Impact, Notched	0.9 - 1.4 J/cm²	4.28 - 6.66 ft-lb/in²	Average = 1.1 J/cm²; Grade Count = 2
Tensile Creep Modulus, 1000 hours	1600 MPa	232000 psi	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+012 - 1e+016 ohm-cm	1e+012 - 1e+016 ohm-cm	Average = 3E+15 ohm-cm; Grade Count = 8
Surface Resistance	1e+010 - 1e+014 ohm	1e+010 - 1e+014 ohm	Average = 3E+13 ohm; Grade Count = 4
Dielectric Constant	4 - 4.4	4 - 4.4	Average = 4.2; Grade Count = 4
Dielectric Strength	15.7 - 18.9 kV/mm	399 - 480 kV/in	Average = 17.3 kV/mm; Grade Count = 2
Dissipation Factor	0.012 - 0.053	0.012 - 0.053	Average = 0.025; Grade Count = 4
Arc Resistance	140 sec	140 sec	Grade Count=1
Comparative Tracking Index	550 V	550 V	Grade Count=1

Thermal Properties

CTE, linear 20°C	36 - 65 µm/m-°C	20 - 36.1 µin/in-°F	Average = 53.2 µm/m-°C; Grade Count=4
Thermal Conductivity	0.46 - 0.49 W/m-K	3.19 - 3.4 BTU-in/hr-ft²-°F	Average = 0.48 W/m-K; Grade Count = 2
Melting Point	253 - 265 °C	487 - 509 °F	Average = 260°C; Grade Count = 16
Maximum Service Temperature, Air	110 - 257 °C	230 - 495 °F	Average = 180°C; Grade Count = 18
Deflection Temperature at 0.46 MPa (66 psi)	210 - 257 °C	410 - 495 °F	Average = 240°C; Grade Count=9
Deflection Temperature at 1.8 MPa (264 psi)	100 - 251 °C	212 - 484 °F	Average = 180°C; Grade Count=23
Vicat Softening Point	200 - 230 °C	392 - 446 °F	Average = 210°C; Grade Count = 3
Flammability, UL94	HB - V-0	HB - V-0	Grade Count = 12, HB is typical

Processing Properties

Processing Temperature	279 - 291 °C	534 - 556 °F	Average = 290°C; Grade Count = 8
Rear Barrel Temperature	290 °C	554 °F	Grade Count = 2
Middle Barrel Temperature	290 °C	554 °F	Grade Count = 2
Front Barrel Temperature	290 °C	554 °F	Grade Count = 2
Nozzle Temperature	280 °C	536 °F	Grade Count = 2
Mold Temperature	66 - 89 °C	151 - 192 °F	Average = 78.6°C; Grade Count = 7
Drying Temperature	80 - 82 °C	176 - 180 °F	Average = 81.5°C; Grade Count = 4

MatWeb, The Online Materials Database

Overview - Nylon 66, Impact Grade

Subcategory: Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.07 - 1.47 g/cc	0.0387 - 0.0531 lb/in³	Average = 1.11 g/cc; Grade Count = 68
Water Absorption	0.8 - 8.5 %	0.8 - 8.5 %	Average = 1.6%; Grade Count = 43
Moisture Absorption at Equilibrium	2.3 - 2.8 %	2.3 - 2.8 %	Average = 2.6%; Grade Count = 3
Water Absorption at Saturation	1.2 - 7 %	1.2 - 7 %	Average = 3.1%; Grade Count = 3
Linear Mold Shrinkage	0.001 - 0.033 cm/cm	0.001 - 0.033 in/in	Average = 0.014 cm/cm; Grade Count = 57
Linear Mold Shrinkage, Transverse	0.019 cm/cm	0.019 in/in	Grade Count = 2
Melt Flow	10 - 105 g/10 min	10 - 105 g/10 min	Average = 71.7 g/10 min; Grade Count = 3
Mechanical Properties			
Hardness, Rockwell M	50 - 94	50 - 94	Average = 66.8; Grade Count = 10
Hardness, Rockwell R	82 - 120	82 - 120	Average = 110; Grade Count = 46
Hardness, Shore D	76 - 83	76 - 83	Average = 79.5; Grade Count = 4

Tensile Strength, Ultimate	35 - 121 MPa	5080 - 17500 psi	Average = 56.9 MPa; Grade Count = 46
Tensile Strength, Yield	30 - 97 MPa	4350 - 14100 psi	Average = 55.3 MPa; Grade Count = 34
Elongation at Break	3 - 270 %	3 - 270 %	Average = 71.6%; Grade Count = 68
Elongation at Yield	4.3 - 210 %	4.3 - 210 %	Average = 25.9%; Grade Count = 13
Tensile Modulus	0.6 - 19 GPa	87 - 2760 ksi	Average = 3.7 GPa; Grade Count = 12
Flexural Modulus	0.7 - 7.6 GPa	102 - 1100 ksi	Average = 2.1 GPa; Grade Count = 62
Flexural Yield Strength	27 - 152 MPa	3920 - 22000 psi	Average = 79.1 MPa; Grade Count = 41
Compressive Yield Strength	30 - 76 MPa	4350 - 11000 psi	Average = 53.4 MPa; Grade Count=7
Shear Strength	41 - 57 MPa	5950 - 8270 psi	Average = 49 MPa; Grade Count = 4
Izod Impact, Notched	0.5 - NB	0.937 - NB	Average = 5.5 J/cm (NB computed as 15 J/cm); Grade Count = 62
Izod Impact, Unnotched	4.64 - NB	8.69 - NB	Average = 13.7 J/cm (NB computed as 20 J/cm); Grade Count = 12
Izod Impact, Notched Low Temp	0.64 - 2.2 J/cm	1.2 - 4.12 ft-lb/in	Average = 1.1 J/cm; Grade Count = 6
Charpy Impact, Unnotched	NB	NB	Grade Count = 8
Charpy Impact, Notched Low Temp	1.6 J/cm²	7.61 ft-lb/in²	Grade Count = 1
Charpy Impact, Notched	0.9 - NB	4.28 - NB	Average = 5.4 J/cm² (NB computed as 10 J/cm²); Grade Count = 8
Tensile Impact Strength	230 - 1680 kJ/m²	109 - 799 ft-lb/in²	Average = 940 kJ/m²; Grade Count = 5
Gardner Impact	9 - 34 J	6.64 - 25.1 ft-lb	Average = 21.5 J; Grade Count = 2
Coefficient of Friction	0.17	0.17	Grade Count=1
Coefficient of Friction, Static	0.23	0.23	Grade Count=1
Tensile Creep Modulus, 1000 hours	450 MPa	65300 psi	Grade Count = 1

Electrical Properties

Electrical Resistivity	1e+011 - 3.2e+015 ohm-cm	1e+011 - 3.2e+015 ohm-cm	Average = 6E+14 ohm-cm; Grade Count = 25
Surface Resistance	1e+009 - 1e+014 ohm	1e+009 - 1e+014 ohm	Average = 3E+130 ohm; Grade Count = 8
Dielectric Constant	2.9 - 5	2.9 - 5	Average = 3.4; Grade Count = 27
Dielectric Constant, Low Frequency	2.9 - 4.8	2.9 - 4.8	Average = 3.6; Grade Count = 11
Dielectric Strength	18 - 90 kV/mm	457 - 2290 kV/in	Average = 34.3 kV/mm; Grade Count = 18
Dissipation Factor	0.01 - 0.2	0.01 - 0.2	Average = 0.051; Grade Count = 19

Dissipation Factor, Low Frequency	0.009 - 0.11	0.009 - 0.11	Average = 0.037; Grade Count = 9
Arc Resistance	95 - 125 sec	95 - 125 sec	Average = 110 sec; Grade Count=6
Comparative Tracking Index	575 - 600 V	575 - 600 V	Average = 600 V; Grade Count=5

Thermal Properties

CTE, linear 20°C	20 - 140 µm/m-°C	11.1 - 77.8 µin/in-°F	Average = 71.6 µm/m-°C; Grade Count=14
Specific Heat Capacity	1.5 - 1.6 J/g-°C	0.359 - 0.382 BTU/lb-°F	Average = 1.5 J/g-K; Grade Count = 2
Thermal Conductivity	0.24 - 0.45 W/m-K	1.67 - 3.12 BTU-in/hr-ft²-°F	Average = 0.3 W/m-K; Grade Count = 4
Melting Point	249 - 265 °C	480 - 509 °F	Average = 260°C; Grade Count = 53
Maximum Service Temperature, Air	46 - 229 °C	115 - 444 °F	Average = 110°C; Grade Count = 49
Deflection Temperature at 0.46 MPa (66 psi)	97 - 248 °C	207 - 478 °F	Average = 210°C; Grade Count=45
Deflection Temperature at 1.8 MPa (264 psi)	46 - 208 °C	115 - 406 °F	Average = 80.9°C; Grade Count=58
Vicat Softening Point	250 °C	482 °F	Grade Count = 2
Brittleness Temperature	-104 - -84 °C	-155 - -119 °F	Average = -94°C; Grade Count=4
Flammability, UL94	HB	HB	Grade Count = 31
Oxygen Index	19 - 24.5 %	19 - 24.5 %	Average = 20.5%; Grade Count = 5

Processing Properties

Processing Temperature	266 - 300 °C	511 - 572 °F	Average = 290°C; Grade Count = 18
Rear Barrel Temperature	260 - 293 °C	500 - 559 °F	Average = 280°C; Grade Count = 6
Middle Barrel Temperature	270 - 293 °C	518 - 559 °F	Average = 290°C; Grade Count = 6
Front Barrel Temperature	280 - 285 °C	536 - 545 °F	Average = 280°C; Grade Count = 6
Nozzle Temperature	280 °C	536 °F	Grade Count = 4
Mold Temperature	66 - 71 °C	151 - 160 °F	Average = 67°C; Grade Count = 5
Drying Temperature	77 - 82 °C	171 - 180 °F	Average = 81°C; Grade Count = 5

MatWeb, The Online Materials Database

Overview - Nylon 66, Mineral Filled, Impact Grade

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs:
Click button for specific proprietary grades that belong to this Overview class.

Proprietary Grades

Please be aware that some proprietary polymers may not be listed because they fall into more than one class or because of ambiguity in manufacturer's information.

Key Words: Polyamide 66; PA66; PA 66; Polyamide 6/6; Polyamide 6,6; Nylon 6/6; Nylon 6,6; Plastics, Polymers

The property data has been taken from proprietary materials in the MatWeb database. Each property value reported is the average of appropriate MatWeb entries and the comments report the maximum, minimum, and number of data points used to calculate the value. The values are not necessarily typical of any specific grade, especially less common values and those that can be most affected by additives or processing methods.

Physical Properties	Metric	English	Comments
Density	1.16 - 1.46 g/cc	0.0419 - 0.0527 lb/in³	Average = 1.34 g/cc; Grade Count = 12
Water Absorption	0.35 - 2.6 %	0.35 - 2.6 %	Average = 0.88%; Grade Count = 9
Moisture Absorption at Equilibrium	1.1 %	1.1 %	Grade Count = 1
Linear Mold Shrinkage	0.006 - 0.017 cm/cm	0.006 - 0.017 in/in	Average = 0.011 cm/cm; Grade Count = 10
Melt Flow	25 g/10 min	25 g/10 min	Grade Count = 1
Mechanical Properties			
Hardness, Rockwell M	89 - 92	89 - 92	Average = 90.5; Grade Count = 2
Hardness, Rockwell R	106 - 120	106 - 120	Average = 120; Grade Count = 9
Tensile Strength, Ultimate	59 - 76 MPa	8560 - 11000 psi	Average = 65.2 MPa; Grade Count = 4
Tensile Strength, Yield	49.6 - 90 MPa	7190 - 13100 psi	Average = 74.4 MPa; Grade Count = 8
Elongation at Break	2 - 21 %	2 - 21 %	Average = 10.7%; Grade Count = 12

Elongation at Yield	2.9 %	2.9 %	Grade Count = 1
Tensile Modulus	2.45 - 7.2 GPa	355 - 1040 ksi	Average = 5.2 GPa; Grade Count = 5
Flexural Modulus	2.62 - 5.5 GPa	380 - 798 ksi	Average = 4.6 GPa; Grade Count = 10
Flexural Yield Strength	82.7 - 131 MPa	12000 - 19000 psi	Average = 110 MPa; Grade Count = 11
Izod Impact, Notched	0.48 - 1.49 J/cm	0.899 - 2.79 ft-lb/in	Average = 0.76 J/cm; Grade Count = 11
Izod Impact, Unnotched	3.74 - NB	7.01 - NB	Average = 9.7 J/cm (NB computed as 20 J/cm); Grade Count = 3
Gardner Impact	14 - 28 J	10.3 - 20.7 ft-lb	Average = 21 J; Grade Count = 2
Coefficient of Friction	0.17	0.17	Grade Count=1
Coefficient of Friction, Static	0.22	0.22	Grade Count=1

Electrical Properties

Electrical Resistivity	10000 - 7.7e+015 ohm-cm	10000 - 7.7e+015 ohm-cm	Average = 3E+15 ohm-cm; Grade Count = 3
Surface Resistance	10000 ohm	10000 ohm	Grade Count = 1
Dielectric Constant	3.7	3.7	Grade Count = 1
Dielectric Constant, Low Frequency	4	4	Grade Count = 1
Dielectric Strength	19.3 kV/mm	490 kV/in	Grade Count = 1
Dissipation Factor	0.015	0.015	Grade Count = 1
Dissipation Factor, Low Frequency	0.008	0.008	Grade Count = 1
Arc Resistance	139 sec	139 sec	Grade Count=1
Comparative Tracking Index	600 V	600 V	Grade Count=1

Thermal Properties

CTE, linear 20°C	49 - 113 µm/m-°C	27.2 - 62.8 µin/in-°F	Average = 70.7 µm/m-°C; Grade Count=3
CTE, linear 20°C Transverse to Flow	89 µm/m-°C	49.4 µin/in-°F	Grade Count=1
Specific Heat Capacity	1.5 J/g-°C	0.359 BTU/lb-°F	Grade Count = 2
Thermal Conductivity	0.4 - 0.45 W/m-K	2.78 - 3.12 BTU-in/hr-ft²-°F	Average = 0.43 W/m-K; Grade Count = 2
Melting Point	232 - 265 °C	450 - 509 °F	Average = 260°C; Grade Count = 9
Maximum Service Temperature, Air	90 - 216 °C	194 - 421 °F	Average = 180°C; Grade Count = 10
Deflection Temperature at 0.46 MPa (66 psi)	202 - 232 °C	396 - 450 °F	Average = 220°C; Grade Count=10
Deflection Temperature at 1.8 MPa (264 psi)	85 - 177 °C	185 - 351 °F	Average = 140°C; Grade Count=10

Vicat Softening Point	140 °C	284 °F	Grade Count = 1
Flammability, UL94	HB	HB	Grade Count = 3

Processing Properties

Processing Temperature	290 - 296 °C	554 - 565 °F	Average = 290°C; Grade Count = 7
Rear Barrel Temperature	290 °C	554 °F	Grade Count = 4
Middle Barrel Temperature	290 °C	554 °F	Grade Count = 4
Front Barrel Temperature	290 °C	554 °F	Grade Count = 4
Nozzle Temperature	280 °C	536 °F	Grade Count = 4
Mold Temperature	66 - 100 °C	151 - 212 °F	Average = 72.8°C; Grade Count = 5
Drying Temperature	82 - 100 °C	180 - 212 °F	Average = 85.6°C; Grade Count = 5

MatWeb, The Online Materials Database

DuPont Zytel® 101 NC010 Nylon 66

Subcategory: Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs: Information provided by DuPont Engineering Polymers.

Material Notes:
Features:

- Colorable
- Wear Resistance, Good
- Chemical Resistance, Good
- Electrical Properties, Good
- Printable
- Spin Weldable
- Ultrasonic Weldable
- Vibration Weldable

Uses:

- Electrical/Electronic Applications
- Appliance Components
- Automotive Applications
- Connectors

Physical Properties	Metric	English	Comments
Density	1.14 g/cc	0.0412 lb/in³	DAM; ASTM D 792
Water Absorption	1.2 %	1.2 %	Immersion 24h; DAM; ASTM D 570
Moisture Absorption at Equilibrium	2.6 %	2.6 %	50% RH; DAM; Similar to ISO 62
Water Absorption at Saturation	8.5 %	8.5 %	DAM; ASTM D 570
Water Absorption at Saturation	8.5 %	8.5 %	DAM; Similar to ISO 62
Linear Mold Shrinkage	0.014 cm/cm	0.014 in/in	Parallel; 2.0 mm; DAM; ISO 294-4
Linear Mold Shrinkage	0.015 cm/cm	0.015 in/in	Flow; 3.2 mm (0.126 in); DAM

Linear Mold Shrinkage, Transverse	0.014 cm/cm	0.014 in/in	2.0 mm; DAM; ISO 294-4
Mechanical Properties			
Hardness, Rockwell M	79	79	DAM; ASTM D 785
Hardness, Rockwell R	121	121	DAM; ASTM D 785
Tensile Strength, Ultimate	77 MPa	11200 psi	50% RH; ASTM D 638
Tensile Strength, Ultimate	83 MPa	12000 psi	DAM; ASTM D 638
Tensile Strength, Yield	55 MPa	7980 psi	50% RH; ISO 527
Tensile Strength, Yield	58 MPa	8410 psi	50% RH; ASTM D 638
Tensile Strength, Yield	82 MPa	11900 psi	DAM; ISO 527
Tensile Strength, Yield	83 MPa	12000 psi	DAM; ASTM D 638
Elongation at Break	Min 50 %	Min 50 %	Nominal Strain at Break; 50% RH; ISO 527
Elongation at Break	Min 300 %	Min 300 %	50% RH; ASTM D 638
Elongation at Break	25 %	25 %	Nominal Strain at Break; DAM; ISO 527
Elongation at Break	45 %	45 %	50 mm/min; DAM; ISO 527
Elongation at Break	60 %	60 %	DAM; ASTM D 638
Elongation at Yield	25 %	25 %	50% RH; ASTM D 638
Elongation at Yield	25 %	25 %	50% RH; ISO 527
Elongation at Yield	4.5 %	4.5 %	DAM; ISO 527
Elongation at Yield	5 %	5 %	DAM; ASTM D 638
Tensile Modulus	1.4 GPa	203 ksi	50% RH; ISO 527
Tensile Modulus	3.1 GPa	450 ksi	DAM; ISO 527
Flexural Modulus	1.2 GPa	174 ksi	50% RH; ISO 178
Flexural Modulus	1.21 GPa	175 ksi	50% RH; ASTM D 790
Flexural Modulus	2.8 GPa	406 ksi	DAM; ISO 178
Flexural Modulus	2.83 GPa	410 ksi	DAM; ASTM D 790
Shear Strength	66.2 MPa	9600 psi	DAM; ASTM D 732
Izod Impact, Notched (ISO)	12 kJ/m²	5.71 ft-lb/in²	50% RH; ISO 180/1A
Izod Impact, Notched (ISO)	5.5 kJ/m²	2.62 ft-lb/in²	DAM; ISO 180/1A
Izod Impact, Unnotched	0.53 J/cm	0.993 ft-lb/in	DAM; ASTM D 256
Izod Impact, Unnotched	1.12 J/cm	2.1 ft-lb/in	50% RH; ASTM D 256

Izod Impact, Unnotched (ISO)	NB	NB	DAM; ISO 180/1U
Izod Impact, Unnotched (ISO)	NB	NB	50% RH; ISO 180/1U
Izod Impact, Notched, Low Temp (ISO)	5.5 kJ/m²	2.62 ft-lb/in²	-40°C; DAM; ISO 180/1A
Charpy Impact, Unnotched	NB	NB	50% RH; ISO 179/1eU
Charpy Impact, Unnotched	NB	NB	DAM; ISO 179/1eU
Charpy Impact, Notched Low Temp	0.3 J/cm²	1.43 ft-lb/in²	-30°C; 50% RH; ISO 179/1eA
Charpy Impact, Notched Low Temp	0.45 J/cm²	2.14 ft-lb/in²	-30°C; DAM; ISO 179/1eA
Charpy Impact, Unnotched Low Temp	40 J/cm²	190 ft-lb/in²	-30°C; DAM; ISO 179/1eU
Charpy Impact, Unnotched Low Temp	NB	NB	-30°C; 50% RH; ISO 179/1eU
Charpy Impact, Notched	0.55 J/cm²	2.62 ft-lb/in²	DAM; ISO 179/1eA
Charpy Impact, Notched	1.5 J/cm²	7.14 ft-lb/in²	50% RH; ISO 179/1eA
Tensile Impact Strength	1470 kJ/m²	699 ft-lb/in²	Long specimen; 50% RH; ASTM D 1822
Tensile Impact Strength	504 kJ/m²	240 ft-lb/in²	Long specimen; DAM; ASTM D 1822
Izod Impact, Unnotched @ -40°C	0.27 J/cm	0.506 ft-lb/in	50% RH; ASTM D 256
Izod Impact, Unnotched @ -40°C	0.32 J/cm	0.599 ft-lb/in	DAM; ASTM D 256

Electrical Properties

Volume Resistivity	1e+013 ohm-cm	1e+013 ohm-cm	50% RH; ASTM D 257
Volume Resistivity	1e+015 ohm-cm	1e+015 ohm-cm	DAM; ASTM D 257
Dielectric Constant	3.6	3.6	DAM; ASTM D 150
Dielectric Constant	3.9	3.9	DAM; ASTM D 150
Dielectric Constant	4	4	DAM; ASTM D 150
Dielectric Constant	4.6	4.6	50% RH; ASTM D 150
Dielectric Constant	7	7	50% RH; ASTM D 150
Dielectric Constant	8	8	50% RH; ASTM D 150
Dissipation Factor	0.01	0.01	100 Hz; DAM; ASTM D 150
Dissipation Factor	0.02	0.02	1 MHz; DAM; ASTM D 150
Dissipation Factor	0.02	0.02	1 kHz; DAM; ASTM D 150
Dissipation Factor	0.1	0.1	1 MHz; 50% RH; ASTM D 150
Dissipation Factor	0.2	0.2	1 kHz; 50% RH; ASTM D 150
Dissipation Factor	0.2	0.2	100 Hz; 50% RH; ASTM D 150

Thermal Properties

CTE, linear 20°C	100 µm/m-°C	55.6 µin/in-°F	Parallel; 23 - 55°C (73 - 130°F); DAM; ASTM E 831
CTE, linear 20°C Transverse to Flow	110 µm/m-°C	61.1 µin/in-°F	23 - 55°C (73 - 130°F); DAM; ASTM E 831
Melting Point	262 °C	504 °F	10°C/min; DAM; ISO 11357-1/-3
Melting Point	262 °C	504 °F	DAM; ASTM D 3418
Deflection Temperature at 0.46 MPa (66 psi)	200 °C	392 °F	DAM; ISO 75-1/-2
Deflection Temperature at 0.46 MPa (66 psi)	210 °C	410 °F	DAM; ASTM D 648
Deflection Temperature at 1.8 MPa (264 psi)	65 °C	149 °F	DAM; ASTM D 648
Deflection Temperature at 1.8 MPa (264 psi)	70 °C	158 °F	DAM; ISO 75-1/-2
Brittleness Temperature	-80 °C	-112 °F	DAM; ASTM D 746
UL RTI, Electrical	130 °C	266 °F	1.5 mm; DAM; UL 746B
UL RTI, Electrical	130 °C	266 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	75 °C	167 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	75 °C	167 °F	1.5 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	85 °C	185 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	85 °C	185 °F	1.5 mm; DAM; UL 746B
Flammability, UL94	V-2	V-2	3.0 mm; DAM; UL94
Flammability, UL94	V-2	V-2	0.71 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-2	V-2	0.71 mm; DAM; UL94
Flammability, UL94	V-2	V-2	1.5 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-2	V-2	3.0 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-2	V-2	1.5 mm; DAM; UL94
Oxygen Index	28 %	28 %	DAM; ASTM D 2863

Processing Properties

Melt Temperature	280 - 300 °C	536 - 572 °F	DAM
Mold Temperature	50 - 90 °C	122 - 194 °F	DAM
Moisture Content	Max 0.2 %	Max 0.2 %	DAM

Descriptive Properties

Color	Natural
Form	Pellets
Processing Method	Injection Moldable
Processing Method	Injection Molding
Processing Method	Extrudable - Filament
Region Available	Americas
Region Available	Asia/Pacific
Region Available	Europe

MatWeb, The Online Materials Database

DuPont Zytel® FR70M30V0 NC010 Nylon 66, 30% Mineral Filler

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs: Information provided by DuPont Engineering Polymers.

Material Notes:
Features:

- Colorable
- Contains Flame Retardant
- Stiffness, Good
- Warpage, Low
- Flame Retardant
- Printable
- Spin Weldable
- Ultrasonic Weldable
- Vibration Weldable

Uses:

- Connectors
- Electrical/Electronic Applications
- Appliances

Physical Properties	Metric	English	Comments
Density	1.62 g/cc	0.0585 lb/in³	DAM; ISO 1183
Density	1.62 g/cc	0.0585 lb/in³	DAM; ASTM D 792
Filler Content	30 %	30 %	
Moisture Absorption at Equilibrium	1.3 %	1.3 %	50% RH; DAM; Similar to ISO 62
Water Absorption at Saturation	4 %	4 %	DAM; Similar to ISO 62
Linear Mold Shrinkage	0.005 cm/cm	0.005 in/in	Flow; 3.2 mm (0.126 in); DAM
Linear Mold Shrinkage	0.008 cm/cm	0.008 in/in	Parallel; 2.0 mm; DAM; ISO 294-4

Linear Mold Shrinkage, Transverse	0.008 cm/cm	0.008 in/in	3.2 mm (0.126 in); DAM
Linear Mold Shrinkage, Transverse	0.009 cm/cm	0.009 in/in	2.0 mm; DAM; ISO 294-4

Mechanical Properties

Tensile Strength at Break	50 MPa	7250 psi	50% RH; ISO 527
Tensile Strength, Ultimate	54 MPa	7830 psi	50% RH; ASTM D 638
Tensile Strength, Ultimate	73 MPa	10600 psi	DAM; ASTM D 638
Tensile Strength at Break	73 MPa	10600 psi	DAM; ISO 527
Elongation at Break	2 %	2 %	DAM; ASTM D 638
Elongation at Break	2 %	2 %	DAM; ISO 527
Elongation at Break	6 %	6 %	50% RH; ASTM D 638
Elongation at Break	6 %	6 %	50% RH; ISO 527
Tensile Modulus	3.5 GPa	508 ksi	50% RH; ISO 527
Tensile Modulus	6.5 GPa	943 ksi	DAM; ISO 527
Flexural Modulus	4.14 GPa	600 ksi	50% RH; ASTM D 790
Flexural Modulus	6.55 GPa	950 ksi	DAM; ASTM D 790
Flexural Strength	115 MPa	16700 psi	DAM; ASTM D 790
Izod Impact, Notched (ISO)	2 kJ/m²	0.952 ft-lb/in²	DAM; ISO 180/1A
Izod Impact, Notched (ISO)	2.5 kJ/m²	1.19 ft-lb/in²	50% RH; ISO 180/1A
Izod Impact, Unnotched	0.27 J/cm	0.506 ft-lb/in	DAM; ASTM D 256
Izod Impact, Unnotched	0.32 J/cm	0.599 ft-lb/in	50% RH; ASTM D 256
Charpy Impact, Unnotched	2.1 J/cm²	9.99 ft-lb/in²	DAM; ISO 179/1eU
Charpy Impact, Unnotched	3 J/cm²	14.3 ft-lb/in²	50% RH; ISO 179/1eU
Charpy Impact, Notched Low Temp	0.2 J/cm²	0.952 ft-lb/in²	-30°C; DAM; ISO 179/1eA
Charpy Impact, Notched Low Temp	0.2 J/cm²	0.952 ft-lb/in²	-30°C; 50% RH; ISO 179/1eA
Charpy Impact, Unnotched Low Temp	1.9 J/cm²	9.04 ft-lb/in²	-30°C; 50% RH; ISO 179/1eU
Charpy Impact, Unnotched Low Temp	2.1 J/cm²	9.99 ft-lb/in²	-30°C; DAM; ISO 179/1eU
Charpy Impact, Notched	0.25 J/cm²	1.19 ft-lb/in²	DAM; ISO 179/1eA
Charpy Impact, Notched	0.3 J/cm²	1.43 ft-lb/in²	50% RH; ISO 179/1eA
Impact Test	240	240	J/m; Unnotched; DAM; ASTM D 4812
Impact Test	280	280	J/m; Unnotched; 50% RH; ASTM D 4812

Electrical Properties

Volume Resistivity	Min 1e+013 ohm-cm	Min 1e+013 ohm-cm	DAM; IEC 60093
Volume Resistivity	1e+009 ohm-cm	1e+009 ohm-cm	50% RH; IEC 60093
Volume Resistivity	1e+014 ohm-cm	1e+014 ohm-cm	DAM; ASTM D 257
Surface Resistance	Min 1e+015 ohm	Min 1e+015 ohm	DAM; IEC 60093
Surface Resistance	1e+015 ohm	1e+015 ohm	DAM; ASTM D 257
Dielectric Constant	3.7	3.7	1 MHz; DAM; IEC 60250
Dielectric Constant	3.7	3.7	DAM; ASTM D 150
Dielectric Constant	3.8	3.8	DAM; ASTM D 150
Dielectric Constant	4.1	4.1	100 Hz; DAM; IEC 60250
Dielectric Constant	4.2	4.2	1 MHz; 50% RH; IEC 60250
Dielectric Constant	9.1	9.1	100 Hz; 50% RH; IEC 60250
Dielectric Strength	16 kV/mm	406 kV/in	3.2 mm (0.126 in); Short Time; DAM; ASTM D 149
Dissipation Factor	0.011	0.011	1 kHz; DAM; ASTM D 150
Dissipation Factor	0.014	0.014	1 MHz; DAM; ASTM D 150
Dissipation Factor	0.014	0.014	1 MHz; DAM; IEC 60250
Dissipation Factor	0.014	0.014	100 Hz; DAM; IEC 60250
Dissipation Factor	0.05	0.05	1 MHz; 50% RH; IEC 60250
Dissipation Factor	0.41	0.41	100 Hz; 50% RH; IEC 60250
Comparative Tracking Index	325 V	325 V	DAM; IEC 60112

Thermal Properties

CTE, linear 20°C	64 µm/m-°C	35.6 µin/in-°F	Parallel; 23 - 55°C (73 - 130°F); DAM; ASTM E 831
CTE, linear 20°C	64 µm/m-°C	35.6 µin/in-°F	Parallel; 23 - 55°C (73 - 130°F); DAM; ISO 11359-1/-2
CTE, linear 20°C Transverse to Flow	81 µm/m-°C	45 µin/in-°F	23 - 55°C (73 - 130°F); DAM; ASTM E 831
CTE, linear 20°C Transverse to Flow	81 µm/m-°C	45 µin/in-°F	23 - 55°C (73 - 130°F); DAM; ISO 11359-1/-2
Melting Point	260 °C	500 °F	DAM; ASTM D 3418
Melting Point	263 °C	505 °F	10°C/min; DAM; ISO 11357-1/-3
Deflection Temperature at 0.46 MPa (66 psi)	238 °C	460 °F	DAM; ISO 75-1/-2
Deflection Temperature at 1.8 MPa (264 psi)	145 °C	293 °F	DAM; ISO 75-1/-2

UL RTI, Electrical	105 °C	221 °F	0.75 mm; DAM; UL 746B
UL RTI, Electrical	120 °C	248 °F	1.5 mm; DAM; UL 746B
UL RTI, Electrical	120 °C	248 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	105 °C	221 °F	1.5 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	115 °C	239 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	95 °C	203 °F	0.75 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	105 °C	221 °F	0.75 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	115 °C	239 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	115 °C	239 °F	1.5 mm; DAM; UL 746B
Flammability, UL94	V-2	V-2	0.75 mm; DAM; UL94
Flammability, UL94	V-2	V-2	0.75 mm; DAM; UL94
Flammability, UL94	V-2	V-2	0.75 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-2	V-2	0.75 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-0	V-0	5VA at 1.5 mm; DAM; IEC 60695-11-20
Flammability, UL94	V-0	V-0	5VA at 1.5 mm; DAM; UL94
Flammability, UL94	V-0	V-0	3.0 mm; DAM; UL94
Flammability, UL94	V-0	V-0	3.0 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-0	V-0	1.5 mm; DAM; UL94
Flammability, UL94	V-0	V-0	1.5 mm; DAM; IEC 60695-11-10
Oxygen Index	37.5 %	37.5 %	DAM; ASTM D 2863
Glow Wire Test	800 °C	1470 °F	Ignition Temperature; 0.75 mm; DAM; IEC 60695-2-13
Glow Wire Test	960 °C	1760 °F	Flammability Index; 0.75 mm; DAM; IEC 60695-2-12

Processing Properties

Melt Temperature	280 - 300 °C	536 - 572 °F	DAM
Mold Temperature	70 - 110 °C	158 - 230 °F	DAM
Moisture Content	Max 0.2 %	Max 0.2 %	DAM

Descriptive Properties

Additive	Flame Retardant
Color	Natural

Form	Pellets
Processing Method	Injection Moldable
Processing Method	Injection Molding
Region Available	Americas
Region Available	Asia/Pacific
Region Available	Europe

MatWeb, The Online Materials Database

DuPont Zytel® FR70M30V0 BK010 Nylon 66, 30% Mineral Filler

Subcategory: Filled/Reinforced Thermoplastic; Nylon; Nylon 66; Polymer; Thermoplastic

Close Analogs: Information provided by DuPont Engineering Polymers.

Material Notes:
Features:

- Flame Retardant
- Chemical Resistance, Good

Uses:

- Electrical/Electronic Applications
- Connectors
- Appliance Components
- Industrial Applications
- Automotive Applications

Physical Properties	Metric	English	Comments
Density	1.62 g/cc	0.0585 lb/in³	DAM; ISO 1183
Filler Content	30 %	30 %	
Linear Mold Shrinkage	0.008 cm/cm	0.008 in/in	Parallel; 2.0 mm; DAM; ISO 294-4
Linear Mold Shrinkage, Transverse	0.009 cm/cm	0.009 in/in	2.0 mm; DAM; ISO 294-4
Mechanical Properties			
Tensile Strength at Break	45 MPa	6530 psi	50% RH; ISO 527
Tensile Strength at Break	65 MPa	9430 psi	DAM; ISO 527
Elongation at Break	2 %	2 %	DAM; ISO 527
Elongation at Break	3.5 %	3.5 %	50% RH; ISO 527
Tensile Modulus	4 GPa	580 ksi	50% RH; ISO 527

Tensile Modulus	6.2 GPa	899 ksi	DAM; ISO 527
Izod Impact, Notched (ISO)	2 kJ/m²	0.952 ft-lb/in²	DAM; ISO 180/1A
Izod Impact, Notched (ISO)	2.5 kJ/m²	1.19 ft-lb/in²	50% RH; ISO 180/1A
Charpy Impact, Unnotched	2 J/cm²	9.52 ft-lb/in²	DAM; ISO 179/1eU
Charpy Impact, Unnotched	2.5 J/cm²	11.9 ft-lb/in²	50% RH; ISO 179/1eU
Charpy Impact, Notched	0.25 J/cm²	1.19 ft-lb/in²	DAM; ISO 179/1eA
Charpy Impact, Notched	0.25 J/cm²	1.19 ft-lb/in²	50% RH; ISO 179/1eA

Thermal Properties

Melting Point	263 °C	505 °F	10°C/min; DAM; ISO 11357-1/-3
Deflection Temperature at 1.8 MPa (264 psi)	145 °C	293 °F	DAM; ISO 75-1/-2
UL RTI, Electrical	105 °C	221 °F	0.75 mm; DAM; UL 746B
UL RTI, Electrical	120 °C	248 °F	1.5 mm; DAM; UL 746B
UL RTI, Electrical	120 °C	248 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	105 °C	221 °F	1.5 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	115 °C	239 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical with Impact	95 °C	203 °F	0.75 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	105 °C	221 °F	0.75 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	115 °C	239 °F	3.0 mm; DAM; UL 746B
UL RTI, Mechanical without Impact	115 °C	239 °F	1.5 mm; DAM; UL 746B
Flammability, UL94	V-2	V-2	0.75 mm; DAM; UL94
Flammability, UL94	V-2	V-2	0.75 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-0	V-0	5VA at 1.5 mm; DAM; IEC 60695-11-20
Flammability, UL94	V-0	V-0	5VA at 1.5 mm; DAM; UL94
Flammability, UL94	V-0	V-0	3.0 mm; DAM; UL94
Flammability, UL94	V-0	V-0	3.0 mm; DAM; IEC 60695-11-10
Flammability, UL94	V-0	V-0	1.5 mm; DAM; UL94
Flammability, UL94	V-0	V-0	1.5 mm; DAM; IEC 60695-11-10
Glow Wire Test	800 °C	1470 °F	Ignition Temperature; 0.75 mm; DAM; IEC 60695-2-13
Glow Wire Test	960 °C	1760 °F	Flammability Index; 0.75 mm; DAM; IEC 60695-2-12

Processing Properties

Melt Temperature	280 - 300 °C	536 - 572 °F	DAM
Mold Temperature	70 - 110 °C	158 - 230 °F	DAM
Moisture Content	Max 0.2 %	Max 0.2 %	DAM

Descriptive Properties

Additive	Flame Retardant
Color	Black
Form	Pellets
Processing Method	Injection Molding
Region Available	Americas
Region Available	Asia/Pacific
Region Available	Europe

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN THE APPLICATION OF:

WIN-CHUNG LEE ET. AL. CASE NO.: AD6995USNA

APPLICATION NO.: 10/799056 GROUP ART UNIT: 1713

FILED: MARCH 12, 2004 EXAMINER: WILLIAM K. CHEUNG

FOR: POLYAMIDE AND POLYVINYLBUTYRAL COMPOSITIONS AND BLENDS COMPRISING MINERAL FILLER AND ARTICLES MADE THEREFROM

REVISED AMENDMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Introductory Comments

Sir:

This Revised Amendment is filed in Response to the Notice of Non-Compliant Amendment (37 CFR 1.121) dated March 30, 2006. The Notice indicates that the Amendment filed March 21, 2006 was non-compliant because the new claims should not have had any underlining. In this Revised Amendment the new claims do not have underlining.

Applicants are filing this Amendment to amend the claims and specification as in the Supplemental Amendment and Second Supplemental Amendment, and to add new claims and respond to comments in the Advisory Action.

Please do not enter the Supplemental Amendment and Second Supplemental Amendment filed after the final Action, and which were not previously entered. In addition, since this Revised Amendment replaces the Amendment filed March 21, 2006, please consider the amendments and remarks in this Revised Amendment in place of those presented in the Amendment filed March 21, 2006.

Amendments to Specification

Please amend the paragraph bridging pages 6 and 7 to read as follows:

In another embodiment, the present invention is a process for preparing the toughened polyamide compositions of the present invention. The toughener of the present invention can be obtained using the process described in WO 0212356. PVB is a commercially available product useful for imparting shatter-resistance to glass in myriad applications, among them windshields for automobiles and window glass in homes and buildings. The preparation of PVB is a well-known reaction between aldehyde and alcohol in an acid medium. The plasticizer used is also a commercially available chemical such as diester of aliphatic diols with aliphatic carboxylic acids, e.g. tri-ethylene glycol di-2-ethylhexanoate (3GO), or tetra-ethylene glycol di-n-heptanoate (4G7). Virgin plasticized PVB sheets (virgin plasticized PVB, as the term is used herein, shall mean PVB that is obtained first-hand from a manufacturer's roll) can be obtained commercially from DuPont under the brandname of BUTACITE®, for example. PVB can be obtained from other sources, as well, including excess PVB obtained from the edge trim from safety or architectural glass manufacturing operations, PVB recovered from scrap automotive or architectural glass, PVB not considered usable in other commercial applications, and other similar sources or mixtures of these sources. Any of these sources can be satisfactorily used without departing from the spirit and scope of this invention.

Please replace Table 2 with the following:

Table 2
Effect of Saline on ECOCITE™ Blends with Mineral Filled Polyamide

	Ex 5	Ex 6	Ex 7	Ex 8
Zytel® 101	51	48	42	42
Silane Silquest® A1100	0.2	0.2	0.2	0.2
ECOCITE™ H (Wt%)	9	12	18	9
Fusabond® A MG423D	-	-	-	9
Translink® HF900	40	40	40	40
Melt Viscosity @ 280°C/2487 s^{-1} (Pa-s)	2337	2124	1860	2125
NI @ 23°C (kJ/m^2)	3.86	4.66	3.76	4.26
NI @ 23°C (J/m)	30.71	37.1	30.03	34.2
UNI @ 23°C (kJ/m2)	60	59.23	48.39	47.98
UNI @ 23°C (J/m)	601.22	592.93	484.39	480.73
TS EL-B (%)	5.6	4.455	6.204	8.33
TS-B (Mpa)	77.868	70.48	66.237	39.539
TS-B (psi)	11301.635	10229.343	9613.563	5738.618
TS-Y (Mpa)	77.947	70.56	66.298	39.6
TS-Y (psi)	11313.104	10240.886	9622.41	5747.502
Flex Mod (Gpa)	6.228	5.664	5.778	3.354
Flex Mod (psi)	903983	822127	838608	486765
Torque (%)	54	57	58	61

Amendments to Claims

1. (Currently Amended) A thermoplastic polyamide composition comprising: (a) from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral; (b) ~~complimentally,~~ 95 to 25 weight percent polyamide that is melt processible below about 320°C and a number average molecular weight of at least 5,000; (c) a mineral filler in an amount of from about 10 to about 45 weight percent of the total composition; and (d) optionally a coupling agent.

2. (Original) The composition of Claim 1 wherein the toughener comprises one or more polymers having anhydride functionality and one or more polymers having carboxylic acid functionality.

3. (Original) The composition of Claim 1 wherein the toughener additionally comprises a non-reactive polymer.

4. (Original) The composition of Claim 3 wherein the non-reactive polymer is selected from the group consisting of polyethylene, polypropylene, polyvinylchloride, nylon, olefinic copolymers, and mixtures thereof.

5. (Original) The composition of Claim 1 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

6. (Currently Amended) The composition of Claim 1 comprising ~~a~~ the coupling agent wherein the coupling agent is an aminosilane compound and is included in an amount of from about 0.1 to about 1 wt%.

7. (Original) The composition of Claim 1 wherein the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid.

8. (Original) An article prepared from the composition of Claim 1.

9. (Original) The article of Claim 8 wherein the article is selected from articles in the group consisting of: toys; furniture; cars; trains; automobiles; appliances; boats; acoustic tiles; acoustic flooring; walls; ceilings; roofs; and, roofing materials.

10. (New) The composition of Claim 2 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

11. (New) The composition of Claim 4 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

12. (New) The composition of Claim 6 wherein the filler is a mineral selected from the group consisting of calcined clay, metal carbonates, titanium dioxide, wollastonite, or talc.

13. (New) The composition of Claim 7 wherein the filler is a mineral selected from the group consisting of calcined

clay, metal carbonates, titanium dioxide, wollastonite, or talc.

14. (New) The composition of Claim 11 wherein the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid.

15. (New) The composition of Claim 12 wherein the polyamide is selected from the group consisting of Nylon 6; Nylon 11; Nylon 12; Nylon 66; Nylon 6, 10; Nylon 12, 12; and copolymers of epsilon-caprolactam with hexamethylenediamine and adipic acid.

16. (New) An article prepared from the composition of Claim 2.

17. (New) An article prepared from the composition of Claim 5.

18. (New) An article prepared from the composition of Claim 14.

19. (New) An article prepared from the composition of Claim 15.

20. (New) The article of Claim 8 wherein the article is selected from articles in the group consisting of: toys; furniture; cars; trains; automobiles; appliances; boats; acoustic tiles; acoustic flooring; walls; ceilings; roofs; and, roofing materials.

REMARKS

Reconsideration is respectfully requested in view of the amendments and remarks herein.

Notice of Non-Compliant Amendment (37 CFR 1.121)

This Revised Amendment is filed in Response to the Notice of Non-Compliant Amendment (37 CFR 1.121) dated March 30, 2006. The Notice indicates that the Amendment filed March 21, 2006 was non-compliant because the new claims should not have had any underlining. In this Revised Amendment the new claims do not have underlining. This Revised Amendment replaces the Amendment filed March 21, 2006.

Obviousness Rejection

Claims 1-9 stand rejected under 35 U.S.C. 103(a) as being obvious over Blatz (U.S. Pat. No. 5,770,654) in view of Hedrick et al. (U.S. Pat. No. 3,419,517).

Claim 1 is directed to a thermoplastic polyamide composition comprising: (a) from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral; (b) 95 to 25 weight percent polyamide that is melt processible below about 320°C and a number average molecular weight of at least 5,000; (c) a mineral filler in an amount of from about 10 to about 45 weight percent of the total composition; and (d) optionally a coupling agent. Claim 8 is directed to an article prepared from the composition of Claim 1.

The first Action states that Blatz discloses all of the claimed features of the present invention except that Blatz does not describe a polyamide composition comprising a mineral filler. The Examiner points to Hedrick to supply the teaching of mineral fillers for polyamide compositions, stating that one of ordinary skill in the art would motivated by an expectation of success to combining the two references and thereby obtain the Applicant's claimed invention.

The final Action states that applicants' arguments filed February 23, 2005 are not considered persuasive. The final Action focused on two points made in applicants' response. First, the Action dismisses applicants' arguments concerning Blatz and Hedrick being improperly combined. The general gist of the Action is that use "consisting essentially of" in Blatz is focused on a preferred embodiment. Second, the Action seems to dismiss applicants arguments pertaining to Notch Izod properties on the basis that the combination of references is strong.

The Advisory Action states that since Blatz column 4, lines 20-23 and 27-31 teaches the "incorporation of inorganic powder or pigments is acceptable", so that "the incorporation of an inorganic material such as filler will not affect the basic properties of the composition of Blatz."

Applicants traverse the rejection for the reasons that (a) the Action improperly combines the two cited patents, improperly reconstructing the invention through hindsight and ignoring the express language of Blatz.

First, applicants point out that Blatz is specifically directed to an unfilled composition. Blatz's use of "consisting essentially of" to describe the Blatz composition in the Summary of the Invention shows Blatz's intention to describe the specific composition described therein, not merely a preferred embodiment.

Blatz discloses polyamide compositions that consist essentially of plasticized polyvinylbutyral and polyamide. These compositions do not include filler.

Most notably, the Summary of the Invention of Blatz uses the transitional phrase "consisting essentially of" in describing the Blatz composition. The Summary of the Invention of a patent describes the invention in the broadest terms contemplated by the inventors and is not merely focused on a preferred embodiment as asserted in the Action.

Here, it is very important to focus on the fact that the phrase "consisting essentially of" appears in the Summary of the Invention, not just in the claims, and that the phrase is used in the first description of the invention, not in describing a preferred embodiment. This shows the intent of the inventors to limit the scope of the invention to the specified materials and those that do not materially affect the basic and novel characteristic(s) of the claimed invention. See, e.g., MPEP 2111.03.

In this regard, applicants strongly assert that addition of 10% or more of mineral filler materially affect the basic and novel characteristic(s) of the claimed invention, and point to the examples in support of this point.

The fact that the Summary of the Invention describes the invention, not simply a preferred embodiment, can be seen from 37 CFR 1.73 and MPEP 608.01(d). A Summary of the Invention is required in a patent application according to 37 CFR 1.73, which states:

> "A brief summary of the invention indicating its nature and substance, which may include a statement of the object of the invention, should precede the detailed description. Such summary should, when set forth, be commensurate

with the invention as claimed and any object recited should be that of the invention as claimed."

MPEP 608.01(d), describes the Summary of the Invention portion of a patent application as follows:

> "Since the purpose of the brief summary of invention is to apprise the public, and more especially those interested in the particular art to which the invention relates, of the nature of the invention, the summary should be directed to the specific invention being claimed, in contradistinction to mere generalities which would be equally applicable to numerous preceding patents. That is, the subject matter of the invention should be described in one or more clear, concise sentences or paragraphs. ..."
>
> "The brief summary, if properly written to set out the exact nature, operation, and purpose of the invention, will be of material assistance in aiding ready understanding of the patent in future searches. ..."

Given the fact that Blatz uses the transitional phrase "consisting essentially of" in the first description of the invention in Blatz's Summary of the Invention, the invention of Blatz was clearly intended to exclude items such as filler. The Summary of the Invention is not merely describing a preferred embodiment, it is describing the invention itself. Therefore, the cited patents can not be combined as in the rejection, and for this reason alone the rejection is an improper hindsight rejection.

The Advisory Action considered the above arguments and took the position that Blatz's contains teachings that show that fillers are contemplated by Blatz. The Action states that since Blatz column 4, lines 20-23 and 27-31 teaches the "incorporation of inorganic powder or pigments is acceptable", so that "the incorporation of an inorganic material such as filler will not affect the basic properties of the composition of Blatz."

Blatz states:

> "The polyamide was in all cases pelletized commercial nylon 6 available from Allied-Signal Company under the trademark CAPRON®. PVB was recovered, colored trim material, in flake form, having dimensions of about 6.35x6.35x(0.5 to 2.0) mm. Recovered plasticized PVB flake is quite tacky and tends to agglomerate. Because of that, it is practical to dust it with an inorganic or organic powder to prevent agglomeration. In this case, PVB flake was dusted with 1% of powdered high density polyethylene. This PVB was made from polyvinyl alcohol obtained from fully hydrolyzed polyvinyl acetate, leaving about 23% of the initial hydroxyl groups free, i.e., unconverted to ketal groups. The plasticizer was tetraethylene glycol di(n-heptanoate), which was present in an amount of about 23% of recovered PVB. Small amounts of dyes, pigments, and stabilizers were also present in this material."

Applicants submit that the Advisory Action misconstrues the teachings of Blatz and the implications thereof. Here, it is necessary to look at the specific teachings of Blatz column 4, lines 20-23 and 27-31, which are cited in the Advisory Action. Column 4, lines 21-23, discusses the problems associated with PVB flake agglomerating. Blatz teaches that it is practical to dust PVB used in the composition with an inorganic or organic powder to prevent agglomeration. Then, Blatz goes on to provide an example of dusting PVB flake with 1% of powdered high density polyethylene. Blatz teaches using small amounts of inorganic or organic powder to prevent agglomeration, such as 1% of powdered high density polyethylene. The person of ordinary skill in the art would not be led by that teaching to disregard Blatz express and repeated use of "consisting essentially of" and add mineral filler in an amount of from about 10 to about 45 weight percent of the total composition to a thermoplastic polyamide composition.

Concerning the above, applicants point out that the claims are directed to use of more than ten times the amount of filler than in Blatz and are using the filler in an entirely different way and for entirely different purposes. Therefore, the person of ordinary skill in the art would not combine the documents as asserted.

Blatz also teaches that "Small amounts of dyes, pigments, and stabilizers were also present in this material." While there is no teaching of the specific amounts of these additives, again applicants point to the fact that Blatz is teaching use of "small" amounts of these additives and does disclose which ones or suitable amounts. Certainly there is no basis for concluding that this teaching would lead the person of ordinary skill in the art to read into the claims that use of mineral filler in an amount of from about 10 to about 45 weight percent of the total composition to a thermoplastic polyamide composition. Moreover, the person of ordinary skill in the art would not consider those amounts of additives to have the significant impact on the composition that the larger amounts used in this invention provide.

Second, applicants point out that Hedrick is describing a composition comprising nylon and mineral filler, but does not teach use of from about 5 to about 30 weight percent of a free-flowing toughener comprising from about 20 weight percent to about 95 weight percent polyvinyl butyral. There is nothing in either reference that would indicate the compatibility of the toughener in filled systems, and thus there is nothing that would motivate the person of ordinary skill in the art to combine the cited patents as in the rejection. Thus, applicants submit that the rejection is based upon an improper hindsight reconstruction of the invention using an improper obvious to try standard.

For the above reasons, applicants respectfully request withdrawal of the rejection of the claims as obvious over Blatz in view of Hedrick.

Amendments

Entry and consideration of the amendments is respectfully requested for the following reasons.

The paragraph bridging pages 6 and 7 is amended to correct an obvious typographical error with the respect to "tri-ethylene glycol di-2-ethylhexanoate (3GO)."

Table 2 is amended to insert the proper labels for the data. Applicants submit that the error and appropriate correction would readily have been recognized by the person of ordinary skill in the art given the use of the appropriate levels and the relationship between the data in Tables 1 and 2. Below is a comparison:

Table 2 Original	**Table 2 Revised**	**Table 1 – Corresponding Portions**
NI @ -30°C (kJ/m^2)	UNI @ 23°C (kJ/m2)	UNI @ 23°C (kJ/m2)
NI @ -30°C (J/m)	UNI @ 23°C (J/m)	UNI @ 23°C (J/m)
UNI @ 23°C (kJ/m2)	TS EL-B (%)	TS EL-B (%)
UNI @ 23°C (J/m)	TS-B (Mpa)	TS-B (Mpa)
TS EL-B (%)	TS-B (psi)	TS-B (psi)
TS-B (Mpa)	TS-Y (Mpa)	TS-Y (Mpa)
TS-B (psi)	TS-Y (psi)	TS-Y (psi)
TS-Y (Mpa)	Flex Mod (Gpa)	Flex Mod (Gpa)
TS-Y (psi)	Flex Mod (psi)	Flex Mod (psi)
Flex Mod (Gpa)	Torque (%)	Torque (%)

Claim 1 is amended to delete "complimentally." Use of this term seems to be in error. First, it is assumed that the term was used to mean that two numbers are "complements" to each other. However, given the difference in the percentages of the three ingredients: (a) 5 to about 30 weight, (b) 95 to 25 weight percent, and (c) 10 to about 45 weight percent, this seems inappropriate. In addition, due to the recitation of an optional coupling agent in claim 1, and since the specification and claims do not seem to intend that other additives not be present.

Claim 6 is amended to provide proper antecedent basis for the first reference to the coupling agent, since the coupling agent is referred to as an optional ingredient in claim 1.

Claims 10-20 are based upon the original claims, with varied claim dependencies.

Entry and consideration are respectfully requested.

Conclusions

In view of the foregoing, allowance of the above-referenced application is respectfully requested. Should any matter remain unresolved by this Response, the Examiner is invited to telephone the undersigned at the below-listed direct dial telephone number in order to expedite prosecution.

Respectfully submitted,

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Dated: April 7, 2006

Appendix C - Related Proceedings Appendix

None.